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## *MOTOR CAPACITY AND SCHEDULE SPEED.*

On other pages of this issue appears the interesting paper entitled "The Relation of Energy and Motor Capacity to Schedule Speed in the Moving of Trains by Electricity," read last week before the American Institute of Electrical Engineers by Dr. Cary T. Hutchinson. The subject is discussed in the paper with extraordinary simplicity and clearness, and the conclusions which Dr. Hutchinson draws are not only of great interest, but of very vital importance to many projects now under way for the extension of electric traction. It has generally been assumed that any degree of acceleration may be conveniently and economically attained by the use of the electric motor, and that the limit to be set upon the acceleration of a passenger train would be that imposed by the physical endurance of the passengers.

Dr. Hutchinson shows that the overall schedule of thirty-five miles per hour for express trains in the New York Rapid Transit Subway is not possible of accomplishment on the assumptions of his discussion. His conclusion that the acceleration giving the lowest motor capacity per ton is most economical in all practical cases is one which will certainly be accepted, and which might have been reached from other premises. The conclusion that a saving of one-tenth of a cent per car-mile in order to increase the rate of acceleration from one to three miles per hour per second is trifling in comparison with the cost of maintenance involved and the discomfort to passengers, is one that should surely be received with interest.

In the exploitation of electric traction systems great care should be taken that no important plant is laid down in such a way as to cause dissatisfaction to its users. Engineering is a wide term and embraces many varieties of provision and forethought. What might figure out as a very satisfactory system indeed, embodying a high rate of acceleration, provided the load carried was freight, might be so uncomfortable for passengers on account of the high acceleration as to make them patronize competing services, should these exist.

Again the depreciation rate is naturally materially increased when motive-power apparatus is subjected to the stresses which are necessarily incident to high acceleration; or, in other words, to the production of very great torque at the instant of starting. On the other hand, for the maintenance of a high rate of overall speed on lines where stops are frequent, a reasonably high degree of acceleration is unquestionably necessary.

Between these extremes there must lie somewhere the happy mean. As electric traction installations are put down for the purpose of earning money and of attracting the public, the comfort of the latter should certainly be given every consideration; indeed, it should have second place, the safety of the passengers, of course, being the consideration of prime importance. Experience on some installations in this country, where the acceleration has been carried to a high point, has shown that under the conditions existing in American cities, where at certain times of the day a considerable proportion of the passengers will be standing in the cars, such accelerations are exceedingly uncomfortable, to say the least. It is to be hoped that in the various installations now under contemplation—no less than three of the very first importance being now under consideration for New York city—this question will be carefully considered and the matter of choosing the proper degree of acceleration referred as much to the possible comfort and convenience of those using the line as to the purely academical problem of moving the train with the least expenditure of energy at the highest overall velocity.

## *ELECTRICAL CARBON BISULPHIDE.*

On other pages of this issue will be found a very interesting account by Mr. Edward R. Taylor of a plant recently erected by him for the manufacture of bisulphide of carbon in the electric furnace. The entire novelty of this method is found in the application of electric heat directly at the point where it is desired to apply it, and the incidental suppression of considerable sources of waste and loss which have occurred in the older processes for the manufacture of this important substance.

Carbon bisulphide is a transparent fluid formed by the union of carbon and sulphur. It has properties of very great importance, such as its ability to dissolve

india-rubber and sulphur, and its power to destroy bacterial and other noxious forms of life. It has found no small use in the electrical arts as the basis for insulating varnishes and paints, and the new process for its manufacture is one that will doubtless result in an extension of its use through the lowering of its price.

The electric furnace has come to play a very important part in the manufacturing arts, but no one who has watched the course of its development in the last few years can fail to see that its applications to industrial processes have only just begun. The possibility of combining electrolytic action, when this is desirable, with any degree of temperature up to a maximum approaching that exhibited in the sun, should make this branch of chemistry one of the most attractive and interesting of all.

### *A FINE CENTRAL STATION.*

The central station of the Citizens' Light and Power Company, of Rochester, N. Y., which is illustrated and described in another place in this issue, presents a number of highly interesting features. In the first place, this plant is built almost immediately at the foot of the Genesee Falls, and notwithstanding this fact uses steam power.

As a matter of fact, water power has been a sort of engineering fetich in this country for several years past. While very great things have been accomplished by its development, the popular impression that anywhere and everywhere and under all conditions water power is practically costless seems to be disappearing in favor of the common-sense view which dictates the examination of all the conditions surrounding any installation. As a matter of fact, water power is often very expensive, and, as in the case of the installation cited, steam for one reason or another, either through its economy or its convenience, which amounts to the same thing, may very profitably compete with it even in a situation apparently as favored as that of Rochester.

Aside from this peculiarity the station has many features of great interest. The situation of the buildings on an abrupt declivity permits the roof of the boiler-house to be used as a coal delivery yard, and gives the company an excellent opportunity for a large storage of fuel. Ashes are removed by the simple and satisfactory process of sluicing the ash-pits by a stream of water from the near-by falls and washing the ashes on a tract of flat land below. The plant reflects no little credit upon its designer, and is an interesting example of the careful adaptation of an installation of this sort to its situation and probable uses.

### *RAILWAY SIGNALS AND SAFETY.*

The discussion concerning the safety of electric railway systems which was precipitated by a recent accident has brought to light very strongly the possibility of interconnecting the source of power and the signals when electric traction is used on a railway system. The methods for accomplishing this are so obvious and so simple as to suggest themselves readily to any one confronted with the problem of railway installation. On the important lines recently constructed by Messrs. Ganz & Company in the north of Italy, the track and working conductor are divided into sections, and each train as it goes along leaves the section through which it has just passed dead behind it. For this reason it is impossible for rear-end collisions to occur, since no train can enter the block which another has just left until the other has gone ahead into the next following block. Such a system would seem on a double-track railroad to make an accident by collision practically impossible.

The automatic feature of this apparatus, however, introduces as many elements of danger as it suppresses. It is not considered good practice either in railway or marine operation to trust too much to automatic devices of any character, but rather to supplement the operation of such apparatus by human intelligence, and *vice versa*. It is not likely that railroads, in this country at any rate, would trust absolutely an automatic block signal system or install such a device in place of the present method of blocking, signaling and despatching. But there is no reason whatever why the interlocking and automatic principles of the switches and signals now employed on first-class railways might not, with electrical equipment, be extended a step further so as to deprive a section on which danger signals were set of power. It does not seem that this really very important feature of electrical equipment has been exploited to a degree commensurate with its value. Practically perfect safety—that is, safety as perfect as human provision can secure—might be attained on a double-track railway by this method. The subject is one that is worthy the close attention of inventors and designers, and it is to be hoped that the agitation now going on concerning high-speed and heavy electric traction equipment, especially in tunnels and other dangerous places, may bear fruit in the development of a simple, reliable and altogether satisfactory system of the character indicated.

### *THE NORTHWESTERN CONVENTION.*

The tenth annual convention of the Northwestern Electrical Association, which recently held its sessions at Milwaukee, was one of the most interesting and entirely successful in the history of that enterprising and vigorous society. For some years past the meetings of this association have been of more than ordinary interest to the central station personnel of this country, the meetings have always been interesting and the discussions more than often valuable. The late convention was no exception to this general rule.

Another thing which is always noticeable about the meetings of this body is that everybody who attends them has a good time. Whether there be some particular quality inherent in northwestern people which makes them enjoy themselves more vigorously than other people is not here to be discussed, but the fact remains that anybody who has been to one of these meetings has brought away a pleasant recollection and has generally decided to come again as soon as he can.

The one hundred and fiftieth anniversary of Benjamin Franklin's kite-flying experiment is near at hand. Some iconoclastic people have cast doubts upon the legend—have even gone so far as to say Franklin did not fly a kite at all, but if he didn't he might have. The date is fairly well established, and the least patriotic electricians can do, we think, is to discover the place of the exploit and erect a monument.

## THE THEORY OF ALTERNATING DYNAMO ELECTRIC MECHANISMS—LIV.

BY W. ELWELL GOLDSBOROUGH.

Having constructed the initial diagram, we can now follow out in Fig. 134 the modifications that are brought about in the magnitude of the different vectors when the load on the alternator is changed; that is, when the resistance $r_1$ of the external circuit is varied. Suppose $r_1$ is reduced to a value $r_1^i$. By equations (54) and (55), we see that this change will cause the value of the current to increase, and that it will lag behind $OA_0$ by a proportionally greater angle. The current vector head B will accordingly move out along the semi-circle $OB^eB^i$ until equilibrium is again established in the circuit by the current reaching its maximum possible value under the new conditions. The vectors $OA_0$ and $OM_0$ remaining fixed in their positions, all the other vectors involved take new positions and values corresponding to the new value of the current by following the arcs of circles passing through their positive extremities to the positions designated by the common exponent letter (*i*). For instance, $OC_0$ will assume its new position in phase with the current, and will have a value equal to $OC_0^i = I^i(r_a + r_1^i)$. $OD_a^i$ will take up its new position lagging 90° behind the current vector $OB^i$, and in magnitude equal to $OD^a = I^i x^a$, since, by equation (53) the electro-motive-force vector $OA_0$ is equal to

$$E_0 = I^i \sqrt{(r^a + r_1^{ai})^2 + \times^2_a} = \sqrt{(OC_0^i)^2 + (C_0^i A_0)^2} \qquad (53)$$

Since the magnetizing power of the armature coils is proportional to the current and in phase with it, the flux vector $M_0M$ will change proportionally in position and magnitude with the current vector, and assume a new position $M_0M^i$; therefore, the resultant magnetism penetrating each armature coil will reduce in value from the resultant flux vector OM to the resultant flux vector $OM^i$, tracing, in so doing, the arc $M^eM^i$ of the semi-circle $M_0M^eM^iO$.

Moreover, since the resistance electro-motive-force drop in the armature is equal to $Ir^a$, and is in phase with the current, the vector head $C_a$, in moving to its new position will trace out an arc of the semi-circle $OC_a^eC_a^i$. This will bring the impedance electro-motive-force vector head $A_a$ to the position $A_a^i$, since, by equation (53),

$$E_a = \sqrt{(OC_a)^2 + (C_aA_a)^2}$$

there is a proportional increase in the length of the vectors, $OC_a$, $C_aA_a$ and $OA_a$.

Up to this point, we have neglected to estimate the power developed by the alternator. When the machine is running on open circuit, no current pulses through the armature, and, consequently, no electric power is developed. When the external resistance is given its first value, $r_1^e$, the alternator develops a total amount of energy equal to

$$P_0^e = (I^e)^2 (r_a + r_1^e). \qquad (92)$$

Of this, only a portion is available for use in the external circuit, namely, an amount equal to

$$P^e = (I^e)^2 r_1^e.$$

By giving the external line resistance, $r_1$, successive values, and constructing the geometrical diagram each time in conformity thereto, the power curves $OP_0^eP_0^k$ and $OP^eP^j$ are traced. These, it will be seen, rise to maximum values. These maxima are, however, not vectorially coincident. For instance, since the vector $OP_0$, in the several phase positions, is equal to the product of the vectors $OC_0$ and OB, this product becomes a maximum when the current lags 45° behind the total internal electro-motive force $OA_0$. On the other hand, the vector OP is the product of the vectors $A_aA_0$ and OB, whose vector heads trace out semi-circles, the diameters (through $O_aA_0$ and $O_bO$) of which have an angular displacement, relatively, to one another that is greater than 90°. When $A_aA_0$ is large, OB is small, and *vice versa*, their instantaneous values being determined in each case by the intersections of parallel vectors with the two semi-circles. The product of the instantaneous values of the vectors $A_aA_0$ and OB, thus determined, will rise to a maximum when the vector OP reaches that position in which it bisects the angle between the diameters drawn through $O_aA_0$ and $O_bO$. (The determination of the exact position occupied by the locus of the vector head $A_a$ will be given later.)

The electrical efficiency of the alternator is equal to the ratio of the line OP to the line $OP_0$. This ratio is a maximum when $r_1 = a$. As $r_1$ diminishes in value, and the current vector OB is made thereby to occupy the successive positions indicated by the dotted vectors, designated by letters (*b*), (*c*), (*d*), (*e*), etc., the efficiency continues to diminish in value until the zero value is attained at the time when $r_1$ = zero.

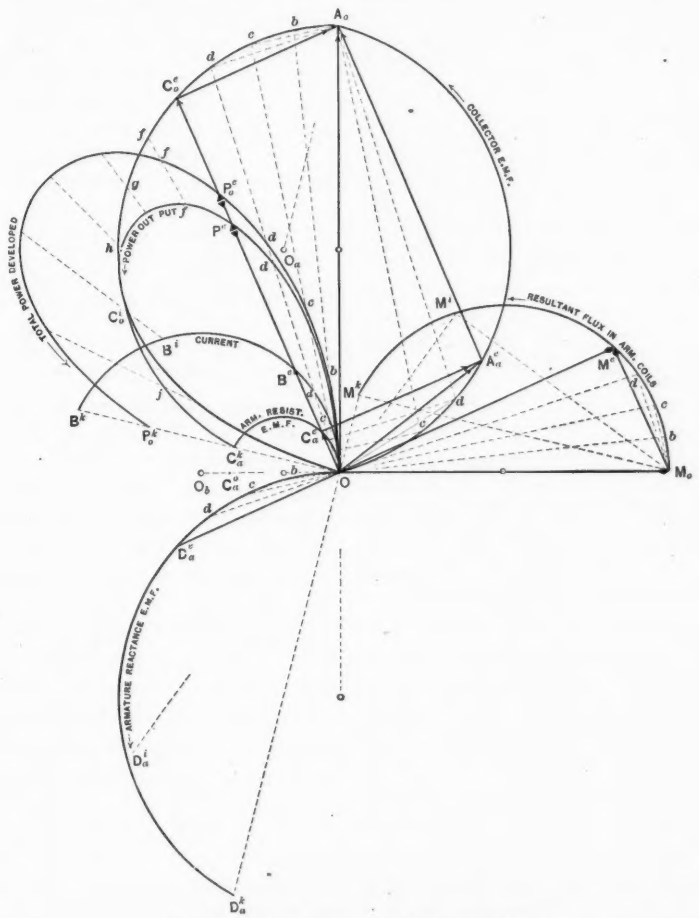



FIG. 134.—ALTERNATING MECHANISMS.

# Science Brevities

**Magnesium—Aluminum Alloys**—There is a distinct advantage, says the London *Electrical Times,* for industrial purposes in using alloys which are definite compounds on account of their being homogeneous, and therefore not liable to unequal corrosion. Considerable attention has been given to the combining of aluminum with magnesium, either by fusing the metals together or by reducing mixtures of alumina and magnesia in the electric furnace. From the specific gravities, Mg 1.74, Al 2.67, it will be seen that one of the valuable properties of aluminum, its lightness, will be enhanced, while the durability is stated to be little affected. M. Boudouard has just announced his discovery of three definite compounds of these metals, obtained from alloys containing thirty to seventy per cent of Al by partially dissolving them with ammonium chloride or hydrochloric acid. They form well defined crystals of the formulæ $AlMg_2$, AlMg and $Al_4Mg$, and the densities 2.03, 2.15 and 2.58, respectively. As shown by their preparation, their resistance to destructive agencies is very decided. But the process is an expensive one, as much of the metal is wasted. If the utility of these compounds should be proved, we may hope that they may be separated by "liquation," or crystallizing out from a molten mass, as in the Pattinson process, or that they may be directly prepared.

**Fatigue of Luminosity**—The reversible cross, first exhibited by Crookes, has been explained on three distinct theories. One of these is heating, the other is chemical change and the third is precipitation of metallic particles which are detached from the cathode. While the first can only explain a temporary change, and the last only a permanent change, a chemical effect might either produce a permanent or a reversible change. To distinguish between these three theories, as abstracted from *Physikalische Zeitschrift,* in *Engineering,* A. Schmauss has made some researches, from which he concludes that the temporary fatigue observed in the case of most substances is undoubtedly due to heating under the influence of cathode rays. The phosphorescent substances are quickly carried beyond the temperature of maximum luminosity, which, indeed, is not very high. The temporary fatigue does not set in so quickly when the phosphorescent substances are cooled in liquid air. As regards the permanent fatigue, the author distinguishes two classes of substances. In the first, to which Balmain's luminous paint belongs, the permanent fatigue is due to changes produced by heat. The substances turn brown, just as they do in heating above a certain temperature. The fatigue sets in in ten minutes in the case of the luminous paint, but requires several hours in the case of chalk. This shows that the fatigue can not be due to the deposition of metallic particles, since these would affect all bodies equally. The temperature of maximum of luminescence lies at seventy degrees for Balmain's luminous paint. Egg-shells and glass shine the brighter the lower their temperature, and in one particular preparation the maximum occurs for red at eighty degrees, for blue at 120 degrees and for green at 180 degrees.

**Earth-Plates**—In using earth-plates for the purpose of diminishing the resistance of telegraph circuits, lightning conductors and the like, it is often assumed, says *Engineering* in an abstract from the *Denkigakkwai Zassi,* that the efficiency of such plates is measured by their area. A. Tanakadate shows that under the ordinary conditions the resistance varies inversely as the linear dimensions of plates of smaller shape. He investigates mathematically the electric resistance of a plane elliptic plate placed in a homogeneous medium of infinite extent, the resistance of the plate itself being negligible compared with that of the medium. He finds that the resistance is nearly constant for ellipses of small eccentricities, but diminishes very rapidly for those of large eccentricities. It follows that great economy of material may be effected by using elongated strips instead of square or round plates. Roughly speaking, a strip of one centimetre by five metres will be enough to replace a plate of one metre square—that is, one-twentieth of the material will suffice. As regards corrosion, more damage may be done by a long, narrow fault than by a round one of the same area.

**Colored Rings Due to Cathode Rays**—W. B. von Czudnochowski has continued his experiments according to an abstract, in an English contemporary, from the *Physikalische Zeitschrift,* on the colors produced by cathode rays on plates of fluorspar. He now employs a double tube consisting of two long tubes joined together so as to form the shape of H, the cathodes being contained in the lower ends, the anti-cathodes in the upper ends, and the anode in the centre of the cross-piece. This arrangement was adopted to test the influence of the geometrical form of the cathode, and thus to shed some light on the nature of the color effect. For this purpose one cathode was made plane while the other was concave. Plates of fluorspar were cemented to the anti-cathodes by means of gypsum. Colored rings were produced on the fluorspar plates, and spread out in the succession: Yellow—red—blue. In the case of the plane cathode three complete orders of colors were observed. In the case of the concave cathode the rings were more regular, but otherwise there was no difference. When examined by transmitted light the plates showed no trace of rings, and nothing but a brown patch shading off toward the circumference. The patch could be wiped off and formed again by a fresh exposure. No trace of grain appeared under the microscope. The cathodes themselves showed the same colored rings, though both were made of aluminum. On carefully polishing the plane cathode the fluorspar acquired, on exposure, a dark blue surface color which could not be rubbed off, but could be got rid of by heating to a red heat, under which the fluorspar showed an intense blue fluorescence. The author does not attempt to explain the phenomena, but points out that disintegration is unknown in the case of aluminum, except at very high temperatures.

**Magnetic Effect of Electric Connection**—In attempting to judge between the contradictory results of Rowland and Crémieu, A. Righi extends the area of enquiry to four closely related phenomena, the existence of any one of which would imply the existence of the other three. Mr. Fournier d'Albe quotes as follows from *Nuovo Cimento:* These four phenomena are the following: A moving electric charge produces a magnetic field. The creation, destruction or variation of a magnetic field produces an electric field. A moving magnetic pole produces an electric field. The creation, destruction or variation of an electric field produces a magnetic field. Of these four phenomena the first is the only one which has been subjected to careful experiment. The second has been scarcely attempted as yet, and the third and fourth have not yet been dealt with. The author points out that the verification of the third phenomenon—that is, a production of an electric field by the motion of a magnet—offers the smallest number of practical difficulties, and announces that he has prepared the apparatus necessary for the experiment. As regards Crémieu's negative result, the author points out that he neglected certain electromagnetic forces whose presence would suffice to counterbalance the phenomenon looked for. He believes, therefore, that Maxwell's theory is in no way invalidated.

# Some Problems in Electric Traction.

**A Paper by Dr. C. T. Hutchinson and Its Discussion at the 160th Meeting of the American Institute of Electrical Engineers.**

THE ONE HUNDRED and sixtieth meeting of the American Institute of Electrical Engineers was held in New York city Friday evening, January 24, 1902. The programme for the evening contemplated papers and discussions bearing on the general subject of the relation between schedule speeds and motor capacity and energy in electric traction.

President Steinmetz in his prefatory remarks stated that the electric railway was certainly furnishing to-day the most important series of problems for electrical engineers and constituting the most important application of electrical engineering in practice. It was a somewhat remarkable fact, he thought, that while in other branches, such as electric lighting and the telephone, very exact data had been attained and very exact formulæ deduced therefrom, in the case of the railway such accurate knowledge and methods were conspicuous by their absence. As a general thing, he said, the problems coming up in electric railway work were solved by purely empirical experimenting. A motor was put on a car for given service, and if it burned out it was obviously too small; if it did not burn out, first one trail car and then another was put on behind. Mr. Steinmetz referred to the first theoretical investigation of the subject in the paper read some years ago before the Institute by Mr. A. H. Armstrong.

The president then, in his usual luminous and felicitous style, set forth the conditions of the problem which engineers must solve in determining the proper class and size of equipment and the proper degree of acceleration to produce given results. The paper of the evening was then read by its author, as follows:

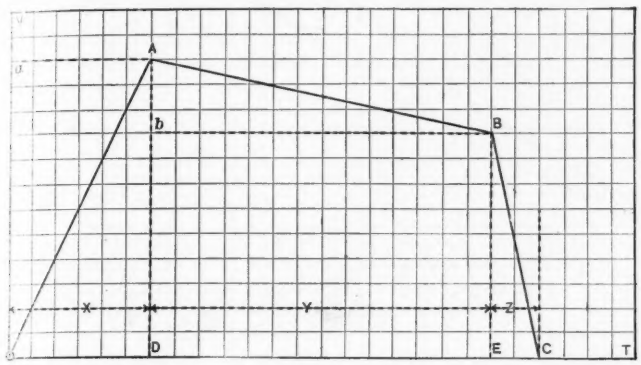



FIG. 1.

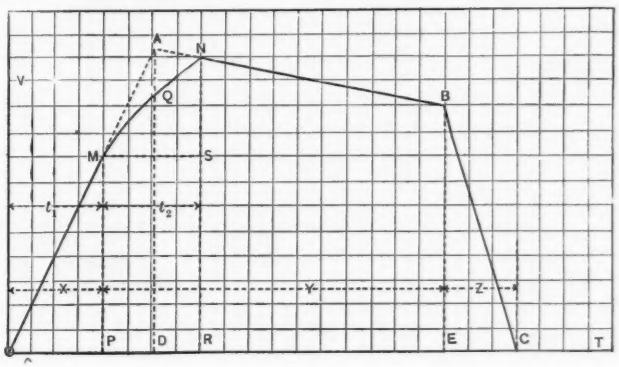



FIG. 2.

THE RELATION OF ENERGY AND MOTOR CAPACITY TO SCHEDULE SPEED IN THE MOVING OF TRAINS BY ELECTRICITY.

BY CARY T. HUTCHINSON.

The determination of the energy and power necessary to make a certain schedule speed from start to start under various conditions of initial accelerations, breaking and use of the "motor curve" is a matter of much practical importance. A number of articles discussing special cases have been published. This paper gives a general solution of the question involved in the movement of a body from rest to rest with velocity varying as shown in Figs. 1 and 2—these two figures illustrating the practical problem of train acceleration. The solution here given covers all cases that can arise in ordinary practice of train movement. It affords a ready means of determining the energy, the power and the losses for any schedule speed, over a course of any length with any initial acceleration, tractive resistance or braking effort, and with any desired use of the "motor curve."

The solution is partly analytical and partly graphical; it may be divided into three stages: (1) The determination of the elements of Fig. 1 to give any schedule speed; this velocity-time ($v$-$t$) curve I shall refer to as the "type curve;" (2) the determination of a general tramway motor curve sheet and the deduction from this curve sheet of several dependent curves; and (3) the application of the general motor curves to the type curve of Fig. 1 to obtain a general solution of the ($v$-$t$) curves of Fig. 2. Each case of Fig. 2 is reduced to a case of Fig. 1 by applying a correction to Fig. 2, represented by the area MAN, by which it is reduced to a corresponding case of Fig. 1.

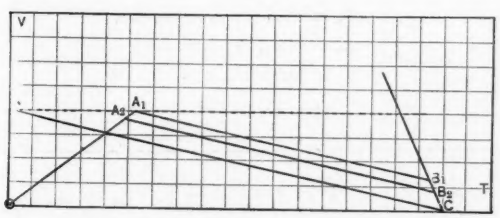



FIG. 3.

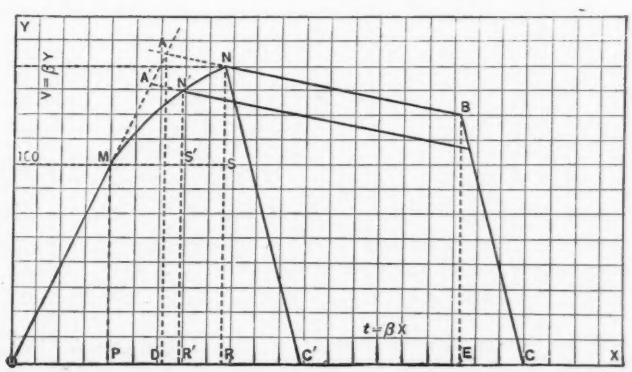



FIG. 4.

Throughout the following units are used:

Velocity, in miles per hour.

Acceleration, in miles per hour per second.

Distance, in feet.

Time, in seconds.

Weight, in pounds.

Power, in kilowatts.

Energy, in watt-hours.

These units are related as follows:

Miles per hour (mph.) = 0.682 feet per second.

Miles per hour per second (mph./sec.) = 0.682 feet per second per second.

Kilowatts (kw.) = $9.1 \times 10^{-5}$w (mph/sec.) (mph.)

Watt-hours (wh.) = $1.25 \times 10^{-5}$ w (mphH)$^2$.

And, therefore,

Kilowatts per ton (kw./ton) = 0.182 (mph/sec.) (mph).

Watt-hours per ton (wh./ton) = $2.5 \times 10^{-2}$ (mph)$^2$.

In this system "$g$" the acceleration of gravity is 32; the ton is uniformly 2,000 lbs.

Referring to Fig. 1, suppose a train to move at constant acceleration from rest to velocity to DA in time OD, then with constant retardation to velocity EB in time DE, and finally with constant retardation from B to C in time EC; the distances traveled in the time OD, DE and EC are represented by the areas OAD, DABE and EDC, respectively, the acceleration by the inclination of the lines to be the horizontal.

Let

$a$ = Acceleration along OA = DA/OD
$b$ = Retardation " AB = A$b$/ED
$c$ = " " BC = BE/EC
$x$ = Time for OA = OD
$y$ = " " AB = DE
$z$ = " " BC = EC
$s_1$ = Distance for OA = Area OAD
$s_2$ = " " AB = " DABE
$s_3$ = Distance for BC = Area EBC
T = Total time = OC
L = " distance = Area OABC
V = Average velocity = 682 L/T

Then these three equations hold:

Velocities: $a\,x - b\,y - c\,z = 0$ (1)

Times: $x + y + z = T$ (2)

Distances: $a\,x^2 - b\,y^2 + c\,z^2 + 2\,a\,x\,y = 2 \times 0.682\,L$ (3)

The work of solving these equations is tedious; I shall give only the results and in a simplified form:

Put

$A = V/T = 0.682\,L/T^2 = 1.47\,V^2/L$ (4)

$2\,A_0 = a\,c/(a + c)$ (5)

$2\,M = (a + b)\,(a + c)\,(c - b)$

$K_1 = (c - b)\,/\,M^{1/3}$

$K_2 = (a + c)\,/M$

$K_3 = (a + b)\,/M^{1/3}$

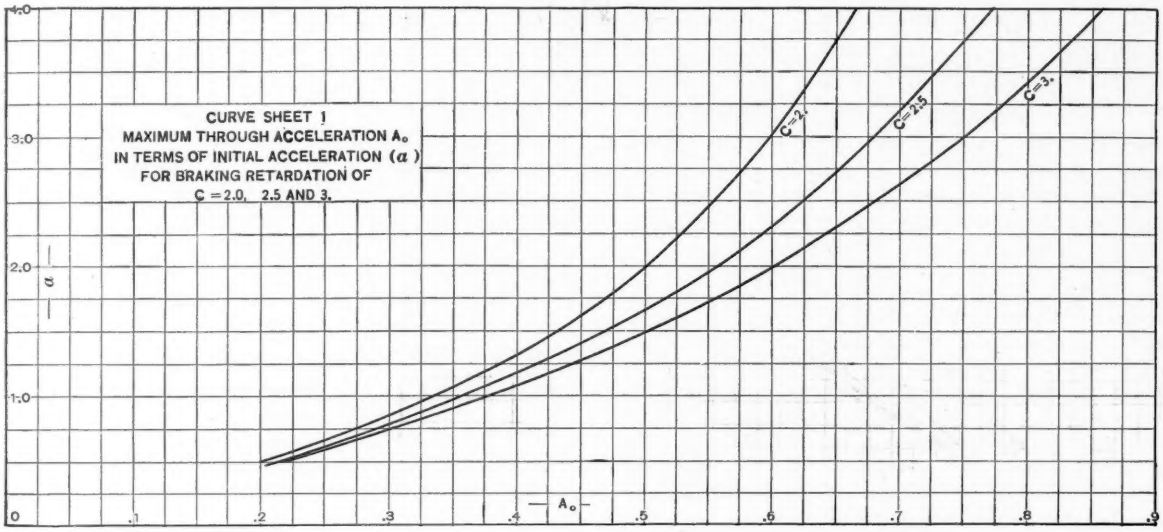
Where

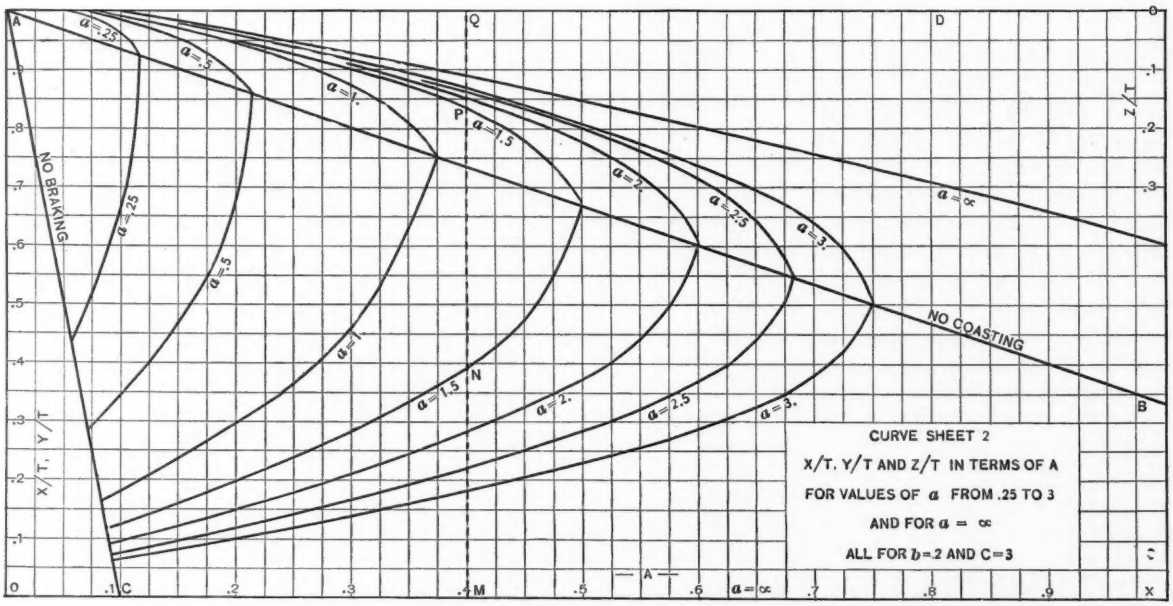
$K_1 + K_2 + K_3 = 0$

Then will

$x/T = 2\,A_0/\,a - K_1\,(A_0 - A)^{1/3}$ (6)

$y/T = K_2\,(A_0 - A)^{1/3}$ (7)




$z/T = 2\,A_0/\,c - K_3\,(A_0 - A)^{1/3}$ (8)

And

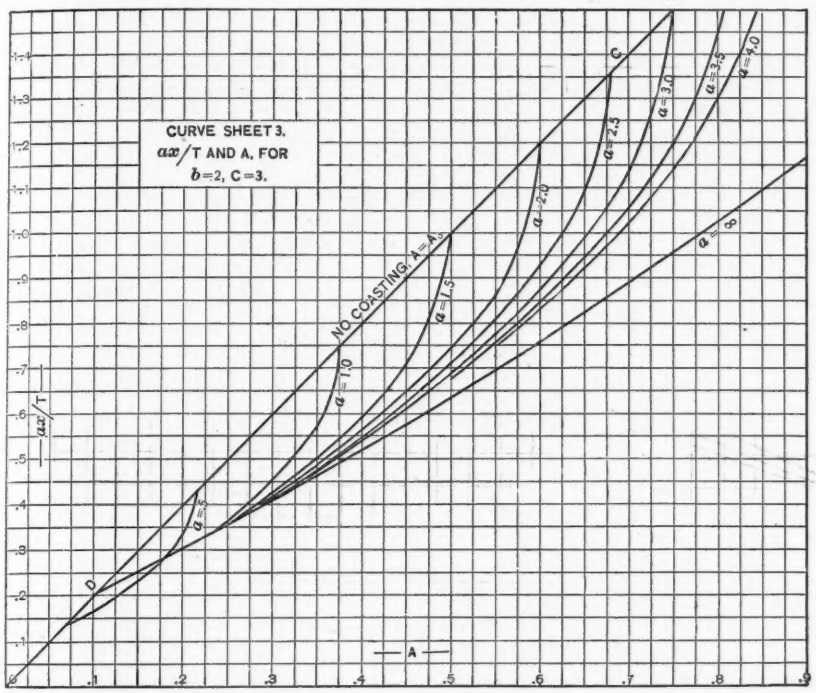
$a\,x/T = 2\,A_0 - a\,K_1\,(A_0 - A)^{1/3}$ (9)

$b\,y/T = b\,K_2\,(A_0 - A)^{1/3}$ (10)

$c\,z/T = 2\,A_0 - c\,K_3\,(A_0 - A)^{1/3}$ (11)

These three equations are the general solution of the problem in kinematics illustrated in Fig. 1; that is, the motion of a particle from rest to rest, with three different accelerations. The only term in the equations containing the average velocity or the length is A; all the other terms are functions of the three accelera-

tions. This quantity A, then, determines completely the schedule. All schedules having the same value of A will be accomplished by the same accelerations in the same proportional times; that is, the same fraction of the total time will be occupied in the three phases of the movement. This quantity is, then, the independent variable, and is of utmost importance in this discussion; it deserves a specific name, and, for want of a better, I shall call it the "through acceleration," and denote it by A. All schedules with the same "through acceleration," but with different V and T, are represented by similar figures, the scale only being different.




These equations show that the maximum through acceleration for given values of $(a)$, $(b)$ and $(c)$ is equal to $A_0$, and that this will occur when $y = 0$; that is, when there is no retardation along AB, or, in electric parlance, "no coasting."

Three special conditions of importance are readily determined:

(1) Infinite acceleration, $a = \infty$

$$x/T = 0$$

$$y/T = \left(\frac{c - 2A}{c - b}\right)^{\frac{1}{2}} \quad (12)$$

$$z/T = 1 - \left(\frac{c - 2A}{c - b}\right)^{\frac{1}{2}} \quad (13)$$

and

$$ax/T = c - (c - b)^{\frac{1}{2}}(c - 2A)^{\frac{1}{2}} \quad (14)$$

(2) No coasting, $y = 0$

$$A_0 = A = ac/2(a + c) \quad (15)$$

(3) No braking, $z = 0$

$$ab/2(a + b) = A$$
$$x/T = b/(a + b) \quad (16)$$

Equation (15) determines the maximum through acceleration, and equation (16) the minimum through acceleration; all possible values lie between these two.

Equation (14) gives the maximum velocity for infinite initial acceleration; this is the least maximum velocity for any value of A greater than $b/2$. For values of A less than $b/2$ the maximum velocity for infinite acceleration is the greatest possible maximum. This seems abnormal, but that it is correct can be seen readily from Fig. 3, where OAC shows the curve for $A = b/2$ and $a = \infty$. Since A is represented by the area of the triangle OAC, it is clear that for an acceleration $OA_2A_1$ the area $OA_1B_1C$ is greater than OAC, and that at some point $A_2$ the area $OA_2B_2C$ will be equal to OAC. That is, when the schedule is slow, the maximum velocity increases with the initial acceleration.

The relations of these quantities are best shown graphically; they are plotted in various ways on the curve sheets described.

Curve sheet 1 is plotted from equation (15), and shows $A_0$ in terms of $(a)$ for $b = 0.2$, and for $c = 2$, 2.5 and 3. These are the maximum values of the through acceleration A in terms of $(a)$ for the several values of $(c)$. They show the influence of $(c)$, the retardation after braking, on $A_0$.

Curve sheet 2 is plotted from equations (6), (7) and (8), and gives the values of $x/T$, $y/T$ and $z/T$ in terms of A for different values of $(a)$ varying from 0.25 to 3.0, and for $a = \infty$; for $b = 0.2$, and $c = 3$.

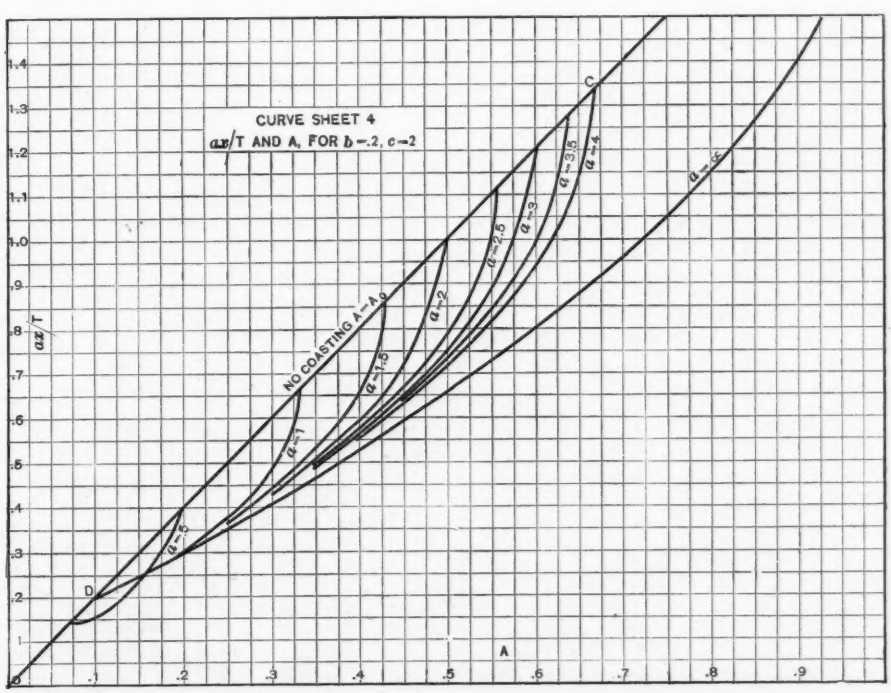
The values of $x/T$ are the intercepts between the X axis and the branch of the $a$ curve lying below the line AB; the values of $y/T$ are included between the two branches of the $a$ curve and of $z/T$ are included between the line AD and the upper branch of the $a$ curve.

For instance, for $A = 0.4$, $a = 1.5$, $x/T = MN$, $y/T = NP$, $z/T = PQ$. The line $a = \infty$ is the axis of X; the line AB is the locus of $y = 0$ or of "no coasting," and the intersection of the $a$ curves with this gives the maximum through acceleration for that value of $(a)$. The line AC is the line of no braking, and its intersection with the $a$ curves gives the minimum values of A.

These curves give all possible values of A, and enable Fig. 1 for any particular case to be drawn at once.

Curve sheet 3 is plotted from equation (9), and gives $a\,x/T$ in terms of A for different values of $(a)$, and for $b = 0.2$, $c = 3$. These curves show at a glance the variation of maximum velocity with different initial acceleration, and the crossing of the $a$ curves.

Curve sheet 4 shows $a\,x/T$ in terms of A for $b = 0.2$ and for $c = 2$. It illustrates the influence of the braking effort on the maximum velocities.



These curve sheets give a complete determination of the kinematics of the problem. There remains the determination of energy and power—the kinetics. I limit the discussion to the case in which power is applied along OA (Fig. 1) only, and the car is allowed to "coast" with gradually diminishing velocity due to the constant retardation ($b$) from A to B where a braking force producing a retardation ($c - b$) is applied, making a total retardation equal to ($c$).

The assumption of ($b$) constant is necessary to a simple discussion; if it is not so, an average value may be used—considerable variations in the value of ($b$) make little difference. I use throughout $b = 0.2$ M.P.H./sec., equal to a force 18.2 lbs. per ton; ($b$) represents the total tractive resistance on a level at uniform speed, and with electric motors, includes motor friction.

The force exerted along OA (Fig. 1) is

$$f = \frac{W}{g}(a + b), \text{ lbs.}$$

and the total energy input at the car axle, per ton, up to the point A is

$$2.50 \times 10^{-2}(1 + b/a)\, a\overline{x^2} \qquad (17)$$

Of this energy

$$2.5 \times 10^{-2} \times a\overline{x^2} \text{ W.H.}$$

is represented by the kinetic energy at point A, and

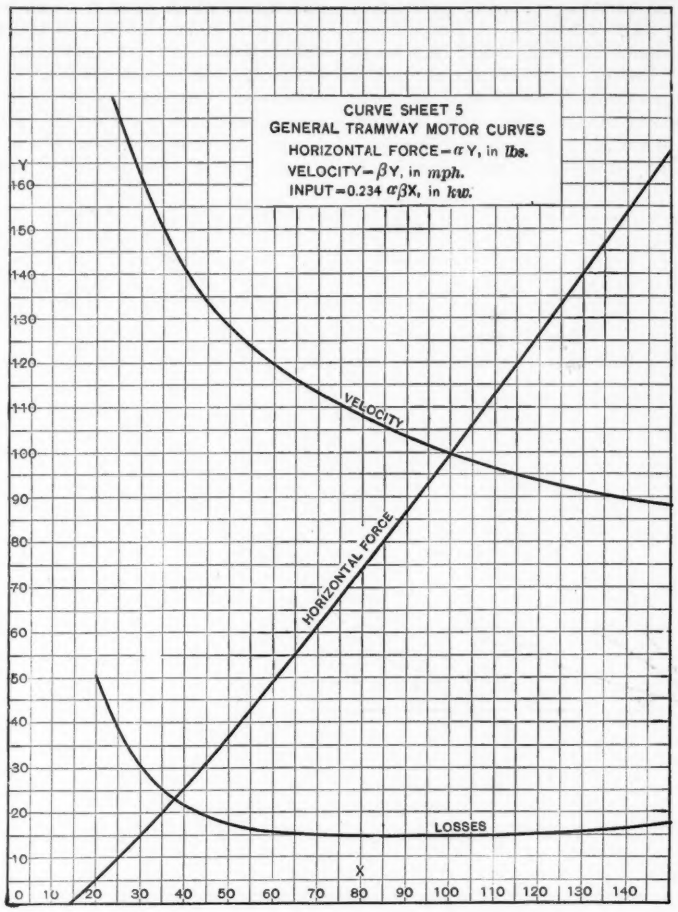
$$2.5 \times 10^{-2}\, a\overline{x^2} \times b/a$$

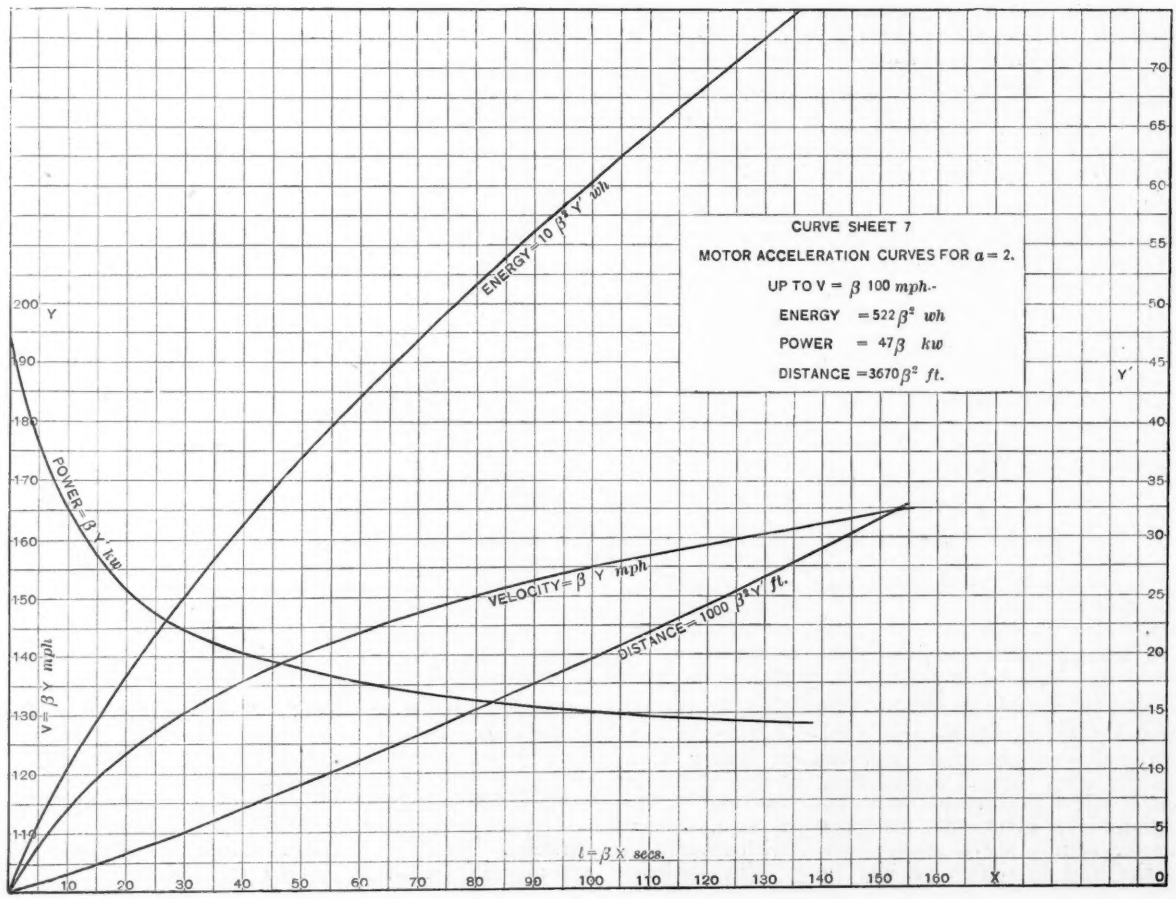
is the work done in overcoming tractive resistances up to point A.

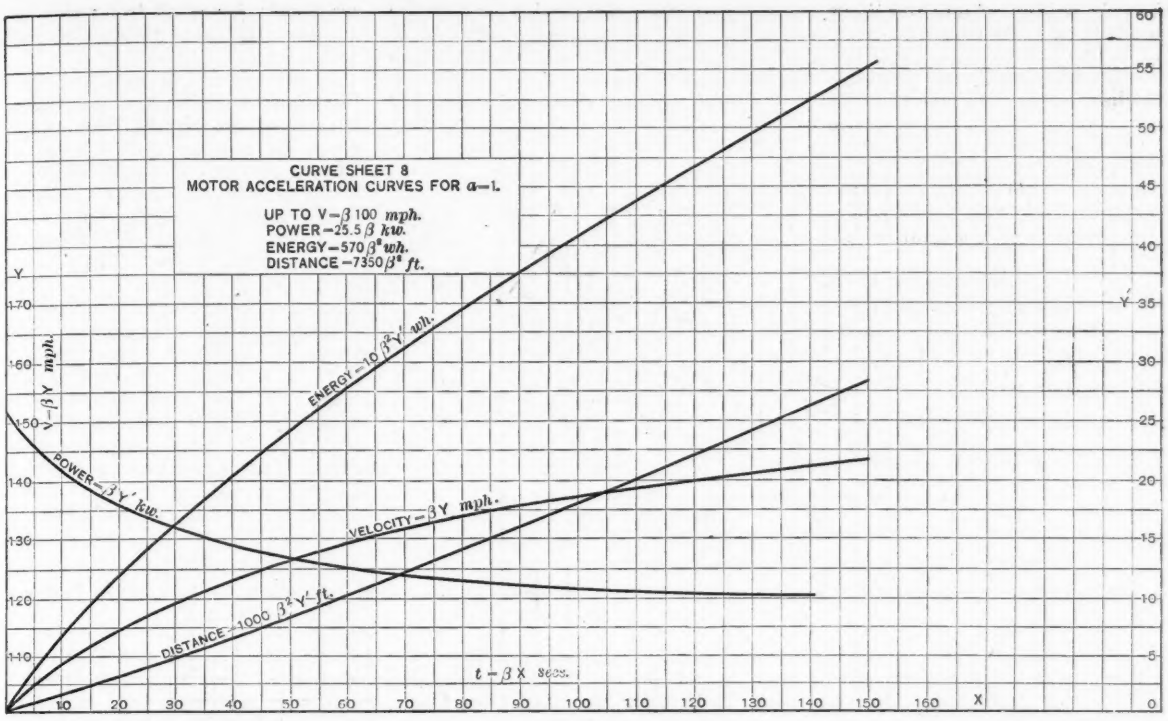
The power per ton is

$$P = 0.182\,(a + b)\, a\, x \qquad (18)$$

Schedule Speed—The relation of schedule speed S to average velocity V is de-





CURVE SHEET 7
MOTOR ACCELERATION CURVES FOR a = 2.
UP TO V = β 100 mph.
ENERGY = 522 β² wh
POWER = 47 β kw
DISTANCE = 3670 β² ft.
ENERGY = 10 β² Y² wh
POWER = β Y' kw
VELOCITY = β Y mph
DISTANCE = 1000 β² Y' ft.
V = β Y mph
t = β X secs.
Y
Y'
X




pendent upon the time of stops at the station. If $t$ is the time of stop at station, then

$$T = 0.682\ L/S - t$$
$$V = 0\ 682\ L/T$$
$$A = V/T = 1.47\ V^2/L \qquad (4)$$

These equations give A in terms of S and L. If $t$ is taken at any constant value, curves can be plotted giving V in terms of S and L; it is, however, simpler to use the equation.

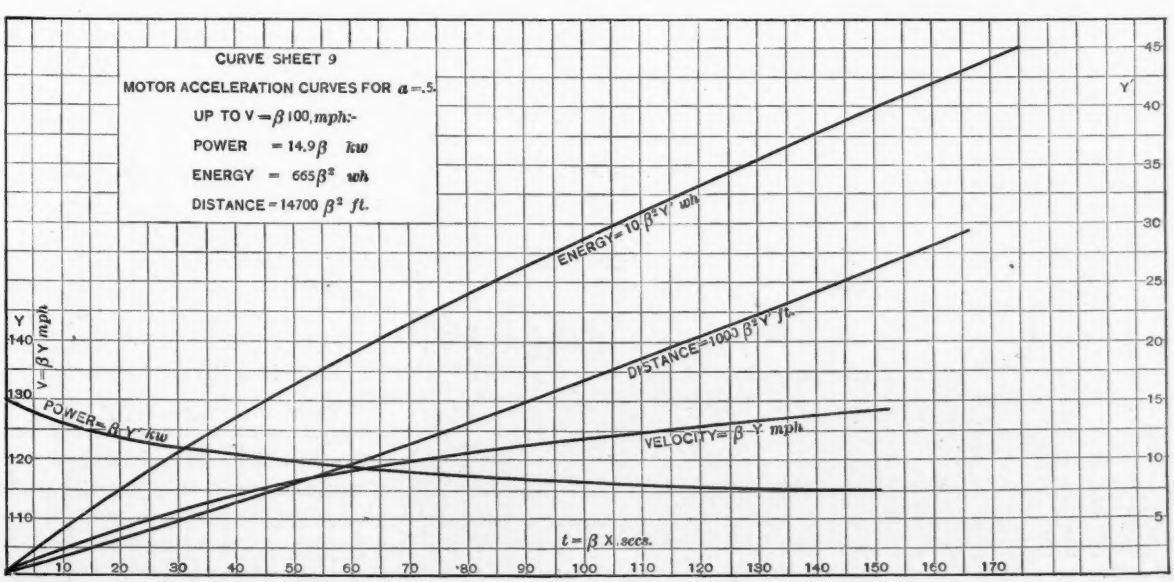
I do not consider the schedule speed further, but assume V and T to be determined from S, ($t$) and L. Knowing A, Curve sheet 2 gives $x/T$ and hence ($a$ $x$) for any values of A. The energy and power are then determined by equations (17) and (18).

These quantities refer to the car axle and do not include losses of any kind in the motor, and hence are of theoretical interest only. If motors had constant efficiency, these values would be proportional to the energy input.

The discussion, to this point, is applicable to any kind of motive power. The matter of practical interest is the application to electric motors, and the determination of the quantities for the ($v$-$t$) curve of Fig. 2; the characteristics of the motor must be taken into account.

General Motor Curves—In order to make the discussion general, it is not sufficient to consider one or two sizes of motor, or one or two gearing ratios; all sizes and all gear ratios must be included, or, what is the same thing, all values of torque at the axle and all values of velocity; in a word, a set of motor curves applicable to all sizes of motors must be prepared.

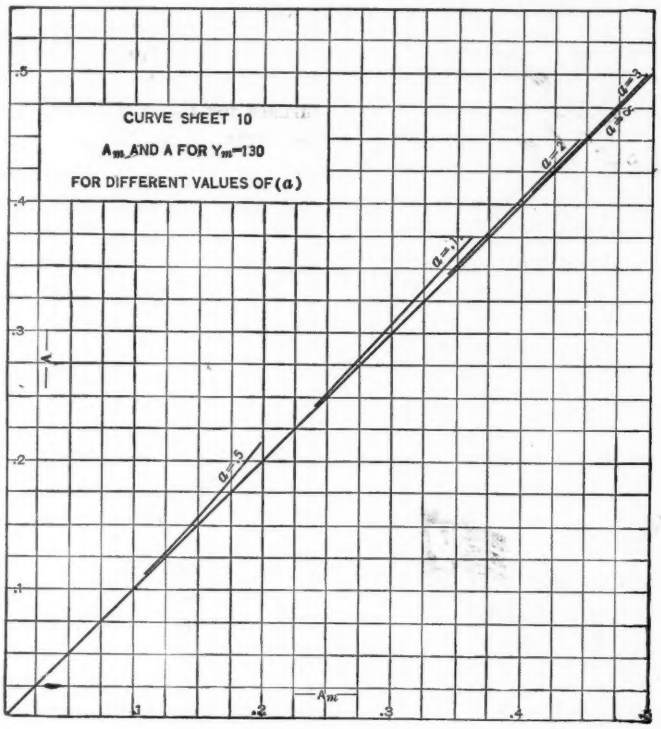
I have plotted the values of torque and speed in terms of input for some twenty tramway motors of different sizes and makes, expressing all quantities in percentage of their value at rated load, and find that the agreement is close, so close that one set of curves can with sufficient exactness for this purpose be used for almost any modern tramway motor built in the United States. It is immaterial whether this general motor curve represents any particular motor. By using this curve, the identically same characteristics are retained for all initial accelerations; hence the use of such a curve brings out the differences due to the different initial accelerations without complicating them by the differences in individual motor characteristics. Curve sheet 5 is this general tramway motor curve; abscissæ are input in kilowatts; ordinates are horizontal force ($f$) in lbs.,



and speed ($v$) in miles per hour; on these curves the rated load is the point (100,100) and is the rating on a one-hour basis, heating to 75° centigrade, the common tramway motor rating. Losses also are plotted; they differ much more in various motors than do ($f$) and ($v$).

The gear ratio, size of wheel and motor capacity must be mutually adjusted to give the required force and velocity at the chosen point of motor input.

I assume in what follows that $\alpha$ and $\beta$ are chosen for rated load; this matter is discussed further under the matter of motor rating.




Let $\beta$ Y′ be the velocity and $\alpha$ Y″ the horizontal force; then every variation in conditions can be met by giving suitable values to $\alpha$ and $\beta$; this use of horizontal force and linear velocity eliminates the gearing ratio and size of wheel, both of which are determined by considerations outside of this discussion. Then for any value of X,

$$f = \alpha\ Y''$$ in lbs.,

and $$v = \beta\ Y'$$ in mph.

The output is

$$[\alpha\ \beta\ Y'\ Y'']/503 \text{ kw.},$$

and the input is

$$[\alpha\ \beta\ Y'\ Y'']/(e \times 503) \text{ kw.},$$

where $e$ is the efficiency at the point (X, Y′, Y″) taken from the motor curve sheet. Choosing the point (100,100,100), the rated load, then $e = 0.85$, and the input is

$$P = 0.234\ \alpha\ \beta\ X, \text{ in kw.} \qquad (19)$$

This determines the constant multiplier for the input in terms of $\alpha$ and $\beta$.

An example will make the use of these curves clear: Suppose a motor is to exert a horizontal force of 2,000 lbs., at a speed of 20 mph.; if this is required at the rated load, then

$$\alpha = 20,\ \beta = 0.2,$$

and $$P = 0.936\ X \text{ kw.};$$

at rated load this motor is 93.6 kw.

It is not necessary to choose the point of rated load; any other point could be taken. For instance, a motor may be assumed to give 2,000 lbs. at 125 per cent torque, and 30 mph. at the corresponding value of the velocity, which is 93.8 per cent; the motor is then carrying a load of 119 per cent.

Acceleration Curves—M (Fig. 2) is the point where the external resistance is all out of the circuit, and the motors begin to run on the "motor curve." The force exerted along OM is proportional to $(a + b)$. Assume this force to be the rated force of the motor and represented by the point Y″ = 100 on the general motor curve. The velocity at M is the rated velocity, is represented by Y′ = 100, and is equal to $\beta$ 100 M. P. H. The acceleration on the motor curve continues to a point N where the velocity is $\beta$ Y′, Y′ having any desired value greater than 100. The share of the curve MQN depends on the relative values of ($a$) and ($b$). If $a/b$ is large the curve is steep; if small, flat. This curve is determined as follows:

The force at any point on the curve, as Q, is

$$\text{Force} = \frac{W}{g}[d\,v/d\,t + b] = \alpha\ Y'' \qquad (20)$$

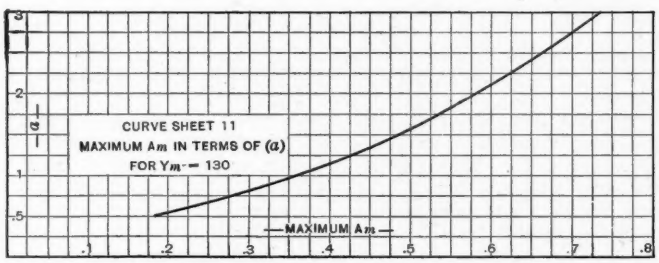
where Y″ is the ordinate of the ($f$) curve of sheet 5. For Y″ = 100 at rated load and point M,

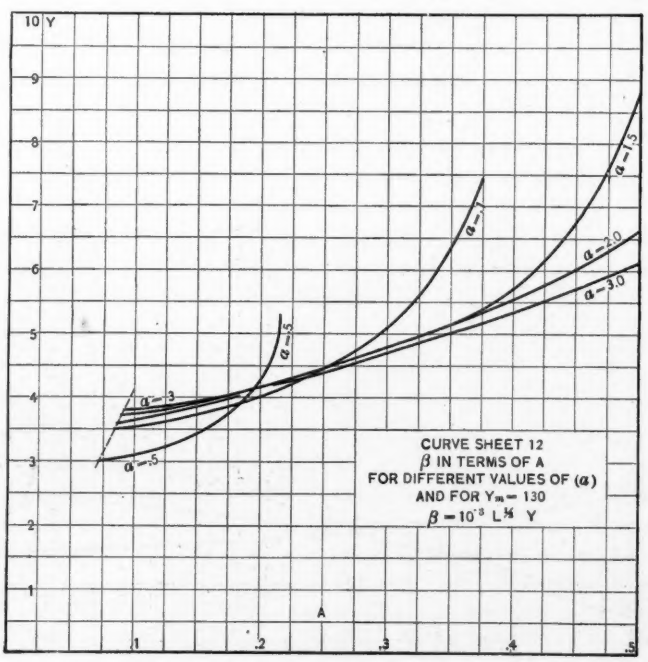
$$d\,v/d\,t = a$$

hence

$$a = \frac{W}{g} \times \frac{(a+b)}{100} \qquad (21)$$

*(To be concluded.)*



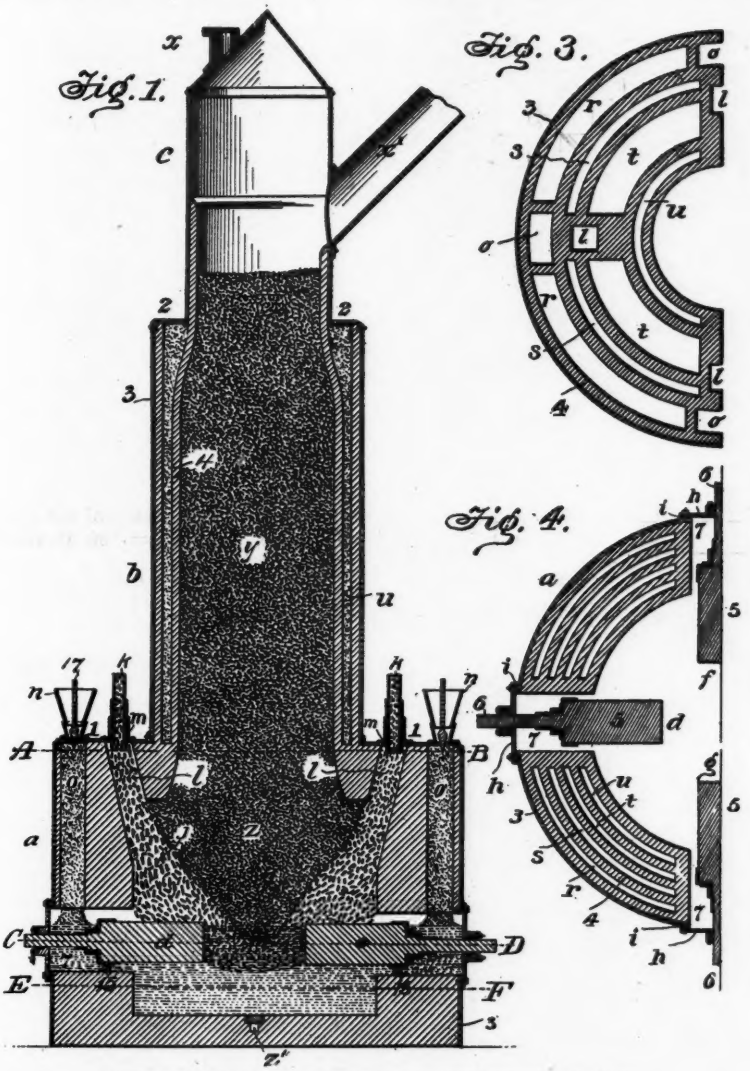
## THE ELECTRICAL MANUFACTURE OF CARBON BISULPHIDE.

BY EDWARD R. TAYLOR.

Responding to your request for information regarding the manufacture of bisulphide of carbon in the electric furnace, at the present day photographs can say so much that few words are necessary to say the rest.

The manufacture of bisulphide of carbon in the electric furnace has grown out of the need for a better process. No large production could be made in the old way, except by the multiplication of retorts, whose size must necessarily be small owing to the difficulty of making heat, externally applied, penetrate. In the first place, a shell is easily destroyed at such temperatures as are necessary for the reactions involved, and the further difficulty exists of getting the heat that passes the shell to penetrate to the centre of the contained charcoal or other form of carbon that may be employed. Added to this is the constant attention required by so many retorts while working, and the frequent tearing down and building up of brickwork, taking out of worn retorts and replacing with new, with all the disorder and great expense involved by such methods.

To get the heat successfully to the interior of a furnace without important loss in transmission and to so utilize it where wanted, as to avoid unnecessary loss of heat by radiation, were the conditions to be attained in a successful solution of the problem.



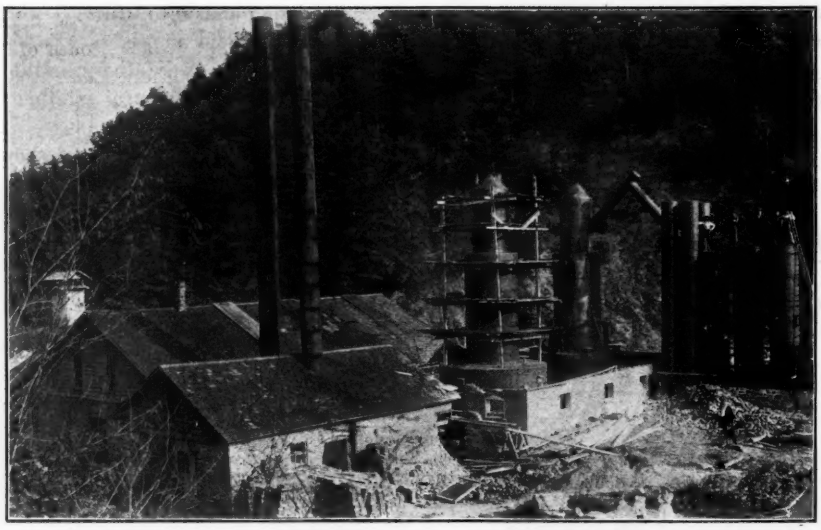

FIGS. 1, 3 AND 4.—ELECTRIC CARBON BISULPHIDE FURNACE.

The illustrations of the furnace shown here are taken from the drawings of a patent issued to the writer for an electric furnace for this purpose. Figs. 1 and 2 are sectional elevations of the furnace, the former illustrating its method of operation. Fig. 3 shows a horizontal section through one side of the furnace on the line AB. Fig. 4 represents a section through the furnace lower down on the line CD. Fig. 5 represents a horizontal section on the line EF at the bottom of the furnace.

The furnace is of upright or stack form —its diameter decreasing toward the top, as shown in the illustrations, and is constructed of iron shell and chambered refractory lining of firebrick or some equivalent substance—extending upward toward the top. The closure plates through which the electrodes pass are carefully insulated with mica and asbestos, these materials being used throughout the furnace for insulating purposes. The gases arising pass off through a side pipe near the top of the furnace.

The feed materials are coke or carbon and sulphur. The latter is placed in the bottom of the working chamber of the furnace and as far up around the electrodes as may be deemed advisable. Fragments of broken carbon or coke are placed upon or between the electrodes, and the whole body of the furnace is filled with charcoal as shown in the illustration. The various annular chambers in the lower part of the furnace are filled with sulphur, which, as it melts and runs in, forms an efficient regulator in the electric current. Sulphur, as is well known, is an insulator, and if the heat becomes too intense more sulphur melts and rising up around the electrode surfaces cuts down

ONE OF THE LOW-HEAD WATER-WHEELS.



General View of the Carbon Bisulphide Works, Partly Completed.

the latter, thus reducing the current flux and the temperature. As the sulphur is vaporized the vapors pass off through the hot charcoal, combining with it and forming the vapor of bisulphide of carbon, which passes off through the side pipe at the top to the condenser.

The electrodes pass through closure plates and packing glands into the interior of the furnace, where they are reenforced by a constant supply of broken carbons or coke that serves to greatly prolong the life of the more expensive electrodes. They also serve as a regulator of the electric current and give it a uniformity of action within the furnace unattainable by movable electrodes.

A further regulation is afforded by the molten sulphur in the bottom of the furnace, the level of which can be regulated at will, and so complete is this control that the current can be entirely cut off by flooding the electrodes.

The conservation of heat in the furnace is also made clear in the drawings—the surrounding concentric passages being filled with powdered sulphur which must be melted by the heat constantly endeavoring to escape through the sides of the structure.

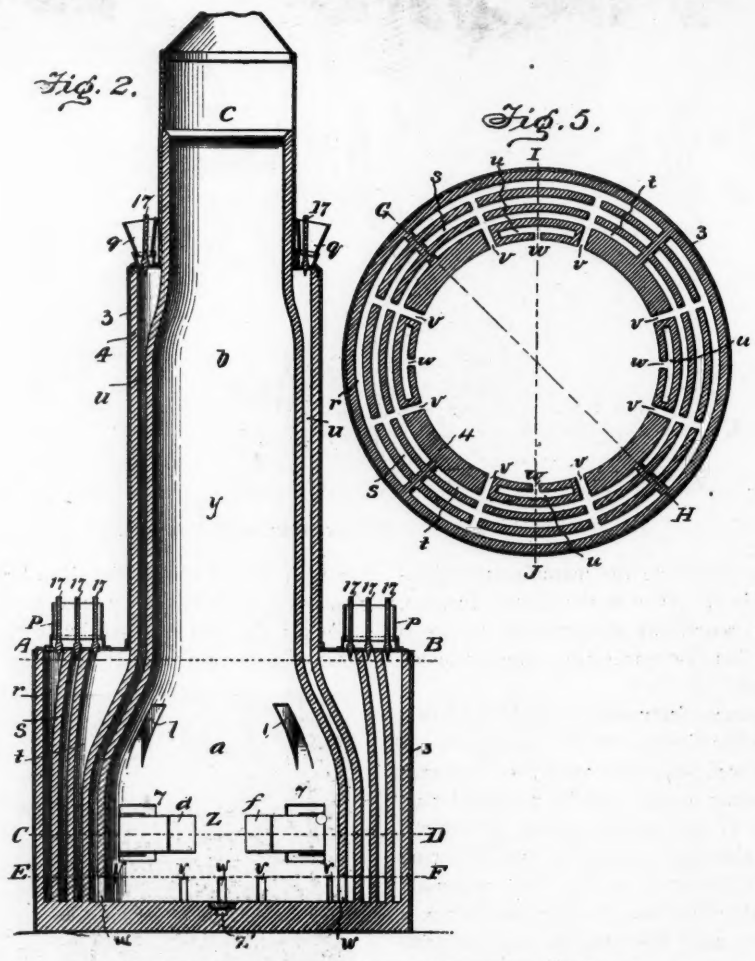
It will be observed that, as this furnace is arranged, both the carbon and the sulphur approach each other in such a gradual manner and under such conditions as to meet each other under the most favorable circumstances for active combination, while the facility of the work leaves absolutely nothing to be desired. It is really a cleaning up of one of the most disagreeable of chemical manufactures.

A plant for the manufacture of carbon bisulphide by this process has been erected at Penn Yan, N. Y., and is shown in the accompanying illustrations. Excellent water power and convenient shipping facilities were found at this site and more than 2,500,000 pounds of bisulphide have been made so far by this process.

The electricity is supplied by two 330-kilowatt two-phase Stanley induction generators, which are giving the utmost satisfaction. They are, however, only running at about half their capacity, as the water is supplied at only about half the available head. This will be increased as early as practicable.

The water-wheels were furnished by the Dayton Globe Iron Works Company, and in their operation leave nothing to be desired. The dynamos are direct-coupled to the water-wheels by the coupling shown in the photograph taken as they were ready to remove in one piece from their works in Dayton, Ohio. The draft tubes are connected to the thimbles shown in the front, and a steel flume eight feet in diameter and sixty feet long connects the wheels to the water through a steel bulkhead communicating with the pond.

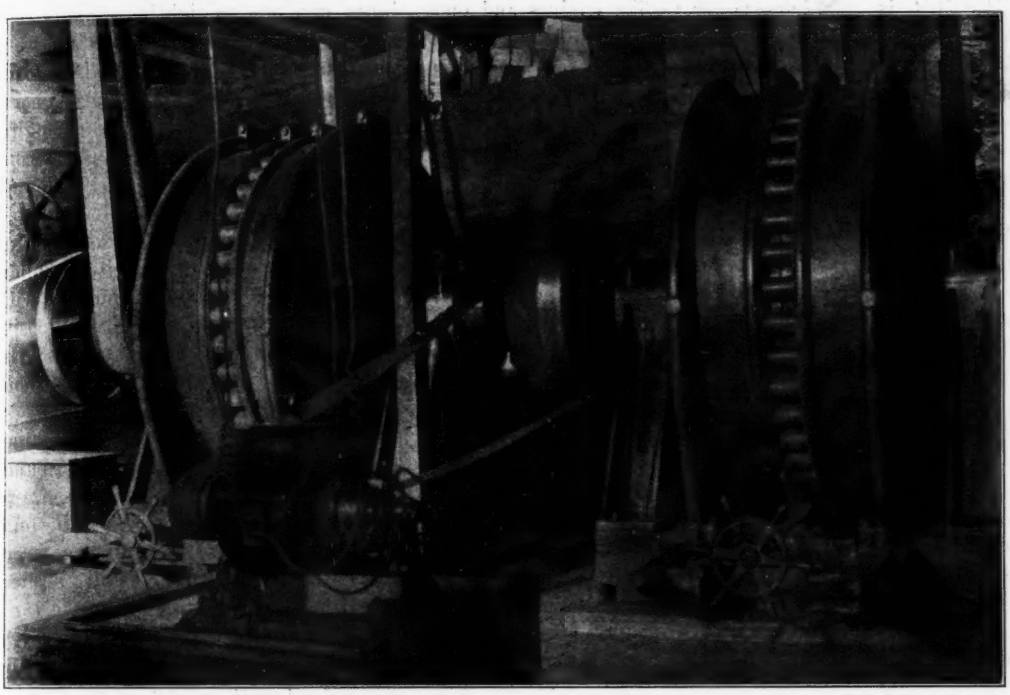
With the present facilities one furnace is producing an output of 8,000 pounds per twenty-four hours, and with the increased water head an output of 20,000 pounds per twenty-four hours is not too much to expect with a correspondingly greater economy. It will, however, be




Figs. 2 and 5.—Electric Carbon Bisulphide Furnace.

several years before the country could absorb so large a quantity.

The current is carried from the generators to the furnace by aluminum bars, three-quarters inch by six inches, which



THE TWO ALTERNATORS FURNISHING CURRENT FOR THE BISULPHIDE FURNACES.

have been found very desirable for this work.

There are two furnaces, and as one furnace can constantly be run for several successive months, it gives ample time to have one furnace in good working order at all times.

Quite in contrast with the old retort method, there is no limit to the practicable size for such a furnace, provided it is supplied with the requisite quantity of electricity. Moreover, the larger the furnace the greater the economy of production, if proper regard for all proportions are maintained.

THE PENSTOCK AND WATER-WHEELS, WITH ONE CARBON BISULPHIDE FURNACE IN COURSE OF ERECTION IN THE BACKGROUND.

Almost nothing is known of the amount of rain on the mountains in Arctic regions. Mr. Hamberg has placed large permanent pluviometers on some high mountains in Swedish Lapland and has observed that much more snow and rain fall there than in adjacent low ground.

**A Samoan Magnetic Observatory.**

The Göttingen Academy of Sciences has decided to establish and maintain at its own expense, during the period of the special international magnetic work, a magnetic observatory near Apia, in the Samoan Islands. The observatory, says *Science,* will be equipped for observations in terrestrial magnetism, atmospheric electricity, meteorology and seismology. This observatory will be nearly magnetically south of the Honolulu Observatory, and about the same distance south of the magnetic equator as the latter is north of it. The two observatories will likewise use practically the same instruments and methods, so that interesting and valuable contributions may be expected from them. Mr. A. Nippoldt, of the Potsdam Observatory, will be in charge of the Samoan Observatory.

In the electric furnace aluminum oxide is not reduced by carbon, but if lime be added, calcium carbide is formed, and Messrs. A. Tucker and Herbert R. Moody have discovered by experiment that this reduces alumina; also that the yield of aluminum is increased by the presence of free carbon. The heat should not be applied longer than fifteen minutes, for by that time aluminum carbide is formed.

An important discovery of hematite iron ore has just been noted near Barrow, England. On the shores of the Duddon estuary, at a depth of ninety feet from the surface, a deposit of rich ore has been pierced to a depth of sixty feet and the bottom has not been reached.

# The Central Station of the Citizens' Light and Power Company, Rochester, N. Y.

THE CITY OF ROCHESTER is situated in Monroe County, in the western part of the state of New York, about seven miles south of Lake Ontario, and is nearly bisected by the Genesee River, which passes through it in a northerly and southerly direction.

The river has three falls and several rapids within the corporate limits having an aggregate descent of about 257 feet, affording power for many manufactories. The city has an area of about sixteen square miles and a population of about 165,000. It has about 321 miles of streets, of which 124 are improved.

The street lighting is almost entirely electric, there being 2,786 arc lamps out of a total of 2,930 street lights.

The major portion of the commercial business in electric light and power lies within the half-mile circle taking the "Four Corners" as a centre, and within this district, on January 1, 1901, there were about thirty miles of tile duct laid in concrete which could be used for light and power purposes. During the last year this has been largely increased.

The arc light circuits comprise about 600 miles of single wire. The incandescent distribution is for the most part on the three-wire system and the balance on the single-phase alternating system.

There are two lighting companies in Rochester, the Rochester Gas and Electric Company and the Citizens' Light and Power Company, and it is with the plant of the latter company that this article has to do. The Citizens' Light and Power Company, which commenced operation in the fall of 1892, had its plant (which is situated on Brown's race and Factory street) ready for business November 17, 1893. Brown's race is an artificial waterway thirty-six feet wide by seven feet deep, running from the Genesee River, at Central avenue, to Brown street, where the overflow returns to the river. The Citizens' Light and Power Company built its plant on the river bank below this race, which gave it a head of ninety-three feet. The original plans were for a building eight stories high, but were finally cut down to three stories and a wheel-pit. The company started in with one or two machines, but at the time of the destruction of the plant by fire, on November 25, 1900, it had installed and operating three 500-horse-power water-wheels, two 600-horse-power Corliss engines and one Woodbury tandem-compound 600-horse-power engine, all of which were connected with four jack-shafts on the floor above by rope drives running 7,000 feet per minute. In the boiler room there were eight horizontal tubular boilers of 125 horse-power each.

A steam plant is a very necessary adjunct, as the Genesee water supply is a very precarious and uncertain quantity, the company being obliged to carry a full head of steam always, as it can take no chances of having its business interrupted.

In summer the water runs almost dry and in the winter is full of ice, and at all times full of rubbish, which the river collects on its way through the city.

On the floor above the shaft room was the dynamo room. In it there were installed six 150-kilowatt double-current Westinghouse dynamos. These machines are similar to a rotary converter, but are belt-driven from clutch pulleys on the jack-shaft below. They gave 380-volt, two-phase, fifty-cycle alternating current from one end and 500-volt direct current from the other end, the idea being to operate all the alternating ends in multiple on the alternating-current switchboard and all the direct-current ends on the direct-current switchboard; but they were finally operated by running the alternating-current ends together and putting in two Westinghouse 150-kilowatt multipolar machines for the 500-volt work, as there was usually a pyrotechnic wind up when they attempted to operate both ends at once. The company also had two Western Electric sixty-light series arc machines, which operated about one hundred commercial arc lamps in stores.

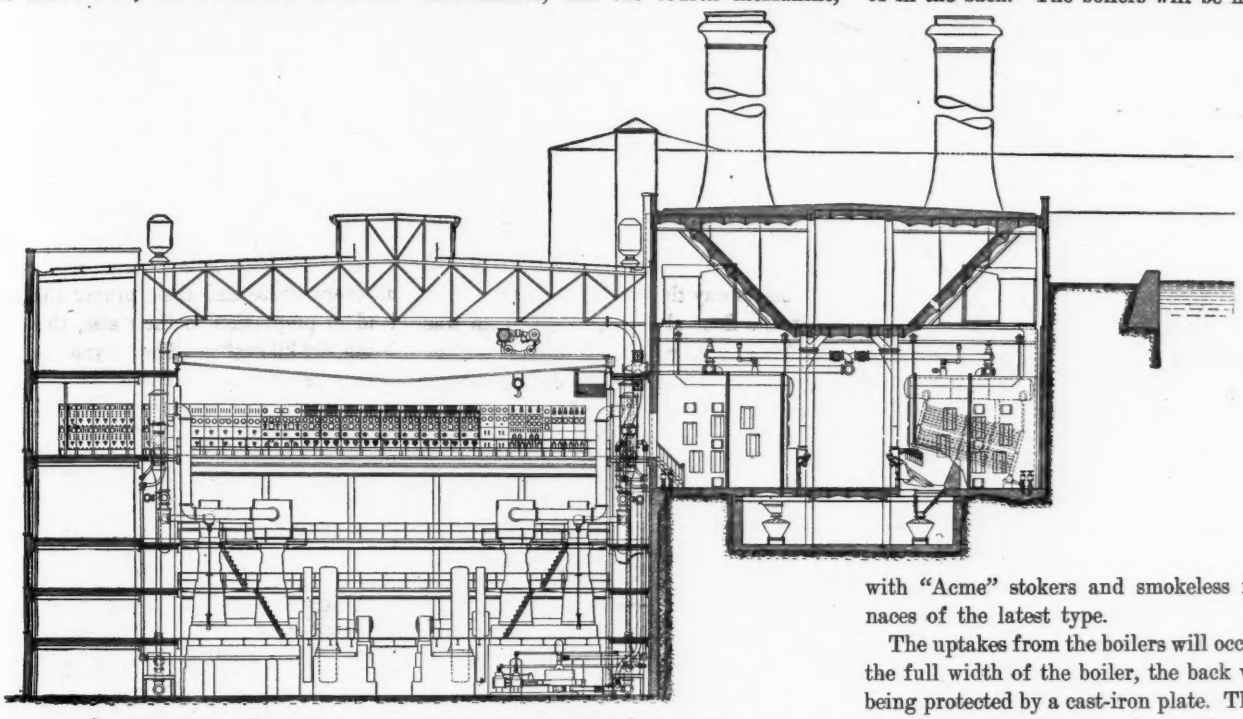
After this plant burned down it was bought by the present company and the old station was reconstructed, to be operated until a modern direct-connected plant could be built. The machinery was not very much damaged by the fire, though all the wooden floors were burned out. The reconstructed station consists of the same engines and water-wheels; one jack-shaft was cut out, and two 180-kilowatt Westinghouse two-phase 2,200-volt composite alternators were installed to replace three of the old double-current machines, three of which were installed again, two being used for power along with the two 150-kilowatt multipolar Westinghouse 500-volt machines, and one on lighting circuits separately. The 180-kilowatt machines were run in multiple on the balance of the load.

Business came in so fast that the company decided to erect a temporary engine at once on the site of the new plant, consequently a direct-connected 500-kilowatt Stanley unit was installed, driven by a horizontal cross-compound Dickson engine and a 650-horse-power water-tube boiler. This machine is also run in multiple with the 180-kilowatt machines, the composite commutators being disconnected and the series and separate winding being connected in series on each machine.

On Christmas eve all these machines were overloaded and had an exact balance on every phase and their proper share of load in proportion to their size, the total being 900 kilowatts. These dynamos were being driven by hand-regulated water-wheels and Corliss engines on the same shafts, and the 500-kilowatt unit by a cross-compound condensing engine, and they worked to perfection. The company also replaced the Western Electric arc machines with three Thomson-Houston arc machines. The 530-volt direct-current power load goes as high as 800 amperes, and the alternating-current lighting load to 400 amperes at 2,260 volts, and two arc machines fully loaded.

Just south of the old station is a piece of property about 200 feet long by 96 feet wide, which was occupied in part by an old factory. This property was acquired and the old buildings were torn down, revealing the solid rock extending from the race on the west, at an elevation of about ninety-nine feet above low water to a factory building on the eastern side, about twenty-three or twenty-four feet above low water. On the south side of the new property is located a large factory building, so that in excavating for the new station it was necessary to channel the rock at a distance from the property line of about two feet, in order to preserve the adjoining foundations from injury. This left a width of about ninety-three feet on which the new station could be built. After a considerable study, it was decided that the engine house should be erected on the end of the lot toward the river, with the boiler house on a step of such height that the coal for use in the station might be driven in the ordinary coal carts from the race street on to the roof and

dumped through holes into a coal pocket, which should be situated above the boilers. The race itself runs in a general northwesterly and southeasterly direction, forty-three feet from the building, along the northern side of the lot and ten feet from the building at the southerly side. The rock on this line was channeled down to about a grade of fifty-eight feet for the main floor of the boiler house. The boiler house basement, which is only of sufficient width to take in the two ash-hoppers and the centre aisle, was channeled down ten feet deeper, while a step of thirty feet was made to take the west wall of the engine room. The solid rock was leveled up with concrete to about the grade of various floors, as shown in the cross-section, and preparation was made for receiving the steelwork, which will shortly be erected.



CROSS-SECTIONAL ELEVATION OF THE ROCHESTER CITIZENS' LIGHT AND POWER COMPANY'S STATION.

The design of the building is similar to that of other large electric lighting stations which have been built in the last year, notably that of the Third avenue station of the Brooklyn Heights Railway Company, Brooklyn, N. Y.

The engine room has mezzanine floors on either side, which support steam piping, condensers and other auxiliary apparatus, leaving the engine room a clear space, devoted to engines only.

The engine house proper is approximately seventy-six feet square inside of the columns, and is spanned by an electric traveling crane of thirty-five tons capacity, made by Alfred Box & Company, of Philadelphia.

The engines themselves are set in two lines, running north and south, with the shafts running east and west, twenty-five feet nine inches from centre to centre.

The generators are outboard of the engine, occupying the centre of the engine room, leaving an aisle ten feet wide between the two lines of generators.

On the east and west sides of the engine room the four mezzanine floors are placed, the two lowest being continuous with the engine platforms; the third mezzanine is used for the support of the condensers and heaters, and the fourth mezzanine, forty-six feet eight inches above the engine room floor, has as its outer edge the support for the crane runway. Eight feet above this mezzanine floor extends the lower chord of the engine room trusses, which span the engine room from wall to wall, ninety feet in the clear. These trusses are nine feet deep at the ends, with the upper chord on a slope one-half inch to the foot, to provide drainage for the roof. A monitor, to give light and afford ventilation for the engine room, extends down the centre of the roof, in north and south directions, above the trusses.

At the south side of the engine room are three electrical galleries; the two lower are twelve feet six inches wide, but the upper, on which the switchboard is located, is sixteen and one-ninth inches wide. On the southeast corner of the engine room an addition extending up the full height of the building, eighteen feet six inches by forty-three feet, serves for additional switchboard space.

The boiler house is eighty-nine feet four inches by sixty-eight feet seven inches in the clear, and will contain ten 650-horsepower B. &. W. type boilers, made by the Aultman & Taylor Company, of Springfield, Ohio. These boilers will be set in four batteries of two boilers each, occupying the four corners of the boiler house, with a single boiler set in the centre of either side occupying the space immediately under the stacks. The boilers are set with no space behind them; cleaning doors being provided at the sides instead of in the back. The boilers will be fitted with "Acme" stokers and smokeless furnaces of the latest type.

The uptakes from the boilers will occupy the full width of the boiler, the back wall being protected by a cast-iron plate. These uptakes go directly upward into the bottom of a flue, which extends the full length of the boiler house on each side, discharging into the bottom of the stacks near the centre of the station. The coal pocket, having a capacity of 1,300 tons, occupies the second story of the boiler house.

The roof over the boiler house is made sufficiently strong to support large coal wagons, which will deliver fuel for use in this station. Numerous hatches are provided, so that the coal may be dumped into the coal pocket and entirely fill it without trimming by hand. The foundations of the stacks are also in this roof, and consist of heavy beams and girders. The stacks themselves are ten feet three inches in diameter, 178 feet above the grates and 130 feet above the base or foundation girders. They are lined for twenty feet above the base with four and one-half-inch firebrick and are two in number, standing on the east and west centre lines of the station, about forty-one feet from centre to centre. The stack itself is made up of thirty feet of three-

eighths-inch plate, fifty feet of five-sixteenths-inch plate, and the upper fifty feet being one-quarter-inch plate. The stacks are surmounted with a "lotus" of neat design, and are furnished with ladders which extend from the roof to the top of the stack. Near the northwest corner of the boiler house roof a bridge, on a grade of five per cent, connects the roof with Brown's race, forming a runway over which the coal carts can pass to attain the roof of the station. From a point on the roof of the engine house, near the centre of the south wall, a cable runway is built above the roof, following the southerly line of the building and bridging Brown's race to a cable tower on the west side of the race. Through this cable runway all the electrical cables of the station will be taken to the underground conduits.

The outside building lines, in many cases, are only six or eight inches away from the rock, which often extends as much as forty feet above the base of the wall, and provision has been made for the water-proofing of the outside of the wall and the proper draining of the space enclosed between the rock and the water-proofing. The walls themselves are to be built of the best hard-burned red brick of selected quality and color. Up to the original rock level the walls are to be laid up in Portland cement, and above this in Rosendale cement. The interior exposed walls of the engine room are to be faced with a hard, light buff, face brick with an enameled brick wainscot running around the engine room about five feet above the floor. This is to be of white enameled brick, with the three lower courses of chocolate-color brick.

All floors, with the exception of the main floor of the engine room, are to be of expanded metal construction, faced with a two-inch coat of granolithic finish. The engine room floor itself is to be made of cast-iron checker plates, three-quarters of an inch thick, and properly ribbed.

The roof of the engine room will consist of terra-cotta roofing tile, laid between T-irons, covered with composition roofing and slag. The roof over the boiler house is to consist of expanded metal arches covered with composition roofing and vitrified paving brick, laid on edge in roofing cement.

As the station has no frontage on the street, the main door of the station will be situated upon the roof, near the partition wall at the south side of the station, and stairs and an elevator will connect this entrance with various floors of engine and boiler rooms.

All window frames and sash are to be of cast iron with bluestone sills. All the other stone trimmings are also to be of bluestone.

The engine and generator foundations are of monolithic concrete moulded in wooden forms. Granite capstones are omitted, as the quality of the concrete will be excellent and the heavy cast-iron engine and generator bases will be leveled up and grouted with fine gravel concrete. Besides carrying the engine these foundations support the floor beams for the main floor.

The engine room proper is seventy-six feet wide, centre to centre of columns, supporting the mezzanines and crane girders, and seventy-six feet six inches long with mezzanine floors on each side six feet ten inches wide. The first two mezzanine floors are on the same level with the engine platforms, the third mezzanine floor is on the same level as the main electrical floor and carries the primary and secondary feed-water heaters and conductors, and the fourth mezzanine floor is six inches below the top of the crane girders and is supported on one side by them, as will be seen by referring to the cross-section of station. The construction of the above floors is of the usual type of girders and floor beams, being proportioned to carry a uniform load of 600 pounds per square foot. Where it was necessary to use built-up girders they were composed of one twenty-four-inch web-plate and four angles, five inches by three and one-half inches, of varying thickness, depending on the load.

The crane girders supporting the thirty-five-ton crane are seventy-six feet, centre to centre, and as it is absolutely necessary that this span be maintained throughout the entire length, a special means of adjustment was designed by which this could be accomplished by the use of packing plates. The engine room roof is carried by four trusses, each having a span of eighty-nine feet eight inches on which rests the nine-inch I-beam purlins, the purlins being supported at the ends of the engine room by rafters, and tees are laid on the purlins to carry the roofing tile.

The boiler house is sixty-nine feet eleven inches wide, centre to centre of columns, and eighty-nine feet long. The boiler fronts, the automatic stoker, the concrete ash-hoppers and part of the side walls of the boilers are supported by the main boiler house floor, but the boiler drums and tube sections are hung from pairs of fifteen-inch I-beams which frame into the horizontal coal-pocket girders. Above the boilers is the coal pocket which is twenty-one feet wide at the bottom with sides sloping at forty-five degrees and seventeen feet six inches high to the bottom of the boiler house roof beams. The girders used in the coal-pocket construction are composed of one web-plate thirty-six inches deep and four angles six inches by six inches, with cover plates fourteen inches wide where necessary. Framing into the lower horizontal coal-pocket girders and running lengthwise with the boiler house are seven 20-inch by 80-pound I-beams forming the floor at the bottom of the coal pocket, which is twenty-one feet wide. The inclined sides are composed of one 20-inch by 65-pound I-beam, two 18-inch by 55-pound I-beams, two 15-inch by 42-pound I-beams, and one 12-inch by 31½-pound I-beam, the largest beam being at the bottom and the size decreasing toward the top, as the pressure of the coal perpendicular to the inclined sides varies from 550 pounds per square foot at the bottom to zero at the top. The bulkheads at the ends of the coal pocket and at the centre, where the uptakes pass up, are constructed of eight-inch by eighteen-pound I-beams placed vertically about three feet six inches apart. Tie rods, seven-eighths of an inch in diameter, spaced about five feet apart, are used in the horizontal floor, and inclined sides and tie rods, three-quarters of an inch in diameter, at the same spacing in the bulkheads.

As the coal is delivered by means of large coal wagons driving over the roof and dumping directly into the coal pocket through any one of the eighteen coal holes, it was necessary to make the roof of a substantial and heavy construction. The girders in the boiler house roof are made up of one web-plate thirty-six inches wide and four angles six inches by six inches, with fourteen-inch cover plates where required, and the floor beams are fifteen-inch by forty-two-pound I's, spaced about three feet six inches apart. In the centre bay of the boiler house are located the two stacks, each stack being twenty feet six inches from the centre of the building. The stacks are supported from the boiler house roof by a heavy system of girders and beams. Each stack is anchored to the girders by eight bolts one and three-quarters inches diameter, with ends upset to two and one-quarter inches. The entire structural work, including the stacks and flues, the stairways and ornamental facia work, is furnished by the American Bridge Company.

BOILERS.

The boilers are of the Babcock & Wilcox type, made by Aultman & Taylor

Manufacturing Company, of Mansfield, Ohio. They are standard double-deck boilers, containing twenty-one sections of fourteen four-inch tubes eighteen feet long, and three forty-two-inch drums about twenty-two feet long. They have a heating service of 6,500 square feet each and are rated at 650 horse-power each on a thirty-pound basis, but are guaranteed to run continuously at a fifty per cent overload. The boilers are designed for a working pressure of 225 pounds, but 175 will be the pressure usually carried. These boilers will be equipped with the "Acme" smokeless furnace and automatic stoker, which will be specially arranged for the smokeless burning of soft coal. The stokers have a large grate surface and are specially designed to meet severe conditions. An interesting feature is the ease and celerity with which the automatic stoker may be converted into a hand-fired grate, or *vice versa*. The front ends of the grate bars are carried in a toggle so arranged that the bars may be placed at any angle from the horizontal to about forty-five degrees, and thus are able to burn many different grades of coal without putting in new bars.

The concrete ash-hoppers are hung from the steel structure immediately below the stokers and discharge into cars which dump into a tubular chute at the northern end of the basement. A stream of water carries the ashes down in the chute to the flat below the station.

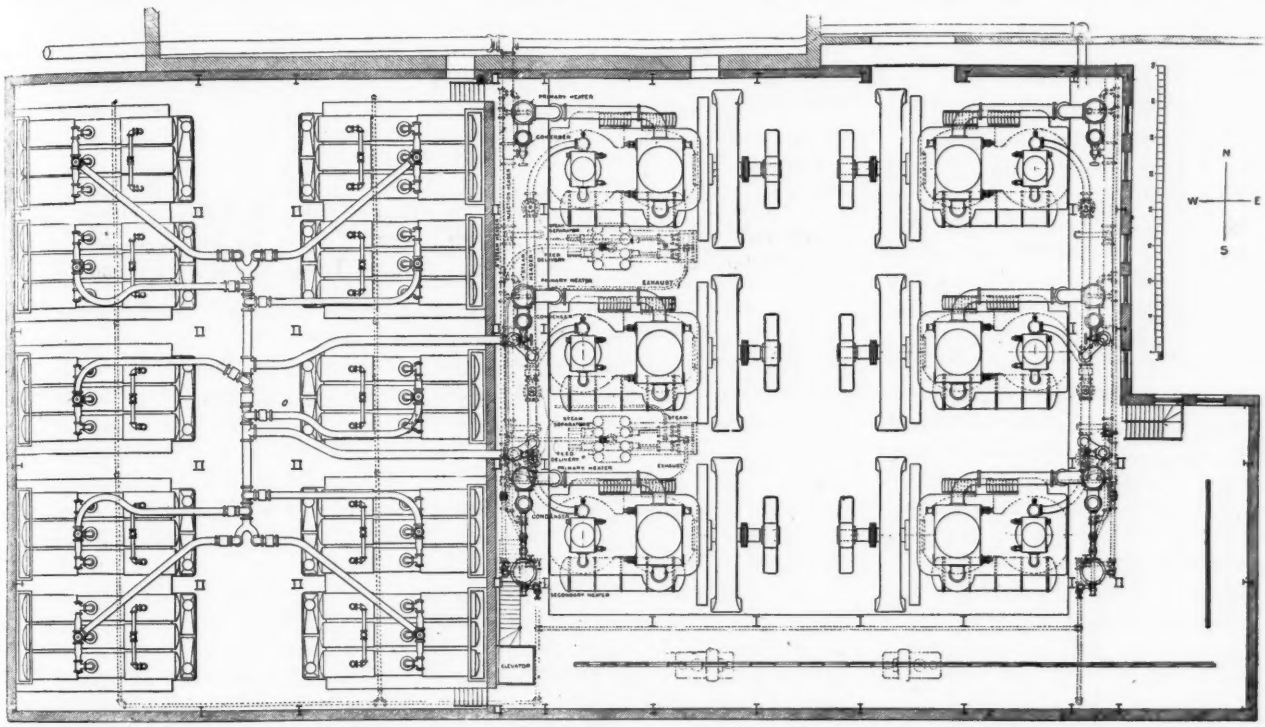
The three drums of the boiler are connected by a standard cross-over pipe for the safety valves and by a special cross-over pipe for the steam connections, both of which are connected to the drums by means of a flexible joint of the ball-and-socket type. In the case of the safety-valve connections the outlets are arranged in the form of a triangle, so that any difference in alignment of the drums will not produce a leak. The steam cross-over connections are laid out with reference to the future use of superheaters, which, throughout the design of the plant, has been kept in view. Nozzles have been provided on these cross-over pipes, so that any of the commercial types of superheater can be readily applied to the boiler.

On the front of each drum a combination stop and check valve is provided for the feed-water inlet, the feed water being brought to this valve by means of bent annealed brass pipes, fed from a loop main, which rises up through the floor on either side of the battery near the front and passes over the top of the boilers. In these risers, about three feet from the floor, are located the main check valves and the straightaway Y stop valve. The blowoff drums, twelve inches in diameter, are fitted with two blowoff connections, which pass out through the side wall of the boiler and are fitted with a standard blowoff valve and special asbestos-packed cock in series.

The safety valves were made by the Star Brass Manufacturing Company, and are of extra heavy type, with nickel seats and mufflers.

The outlet nozzle of the cross-over pipe supports a steam-actuated stop and check valve. This valve has all the advantages of the ordinary stop and check valve, with the additional advantage that it can be closed from several stated points in the station by means of pilot valves. These valves are made by the Davis Regulator Company. From these automatic stop valves the ten-inch bent steel pipe connections are made to the fourteen-inch boiler steam main which is located in a north and south direction in the centre of the boiler room. These ten-inch connections, where they enter the main, are provided with a gate valve. The steam main is so laid out that practically no vibration can occur, all expansions being taken care of by long radius bands properly supported from the coal-pocket floor above.

The main itself is provided with cutoff valves at the proper points, so that it may be divided up into sections. Between the second and third mezzanines on either side of the engine room the fourteen-inch engine room steam mains are located. These mains are connected with the boiler room steam mains by means of two fourteen-inch bent steel pipes, which run near the centre of the station from the boiler room main and through the walls to a T-connection in the engine room above the fourth mezzanine, where they branch downward into




GROUND PLAN OF THE ROCHESTER CITIZENS' LIGHT AND POWER COMPANY'S STATION.

a fourteen-inch connection to the westerly engine room main and upward through twelve-inch bent steel pipes carried by the lower chord of the main trusses to the easterly side of the station. A footwalk alongside the main is provided in each case. Due provision has been made in all this piping for the taking care of expansion and vibration.

The engine connections are taken from the under side of the main and dropped directly into a separator, from which a twelve-inch horizontal bent pipe of large radius conducts the steam to the engine throttle. All valves in this high-pressure steam system are of the Chapman make, the valves being by-passed.

The station is designed to accommodate six vertical cross-compound engines, three of which are at present being built in the shops of the Southwark Foundry and Machine Company, Philadelphia.

Each engine is arranged to drive one 1,200-kilowatt, 2,400-volt, 60-cycle alternator, placed between the low-pressure side of the engine and outer pedestal.

The diameters of the cylinders are twenty-eight and sixty-eight inches, giving a ratio of six, and the stroke forty-eight inches. The engines are designed to run at a normal speed of ninety revolutions per minute, with an initial steam pressure of 160 pounds and a vacuum of twenty-six inches. Under these conditions each engine will develop 1,800 horse-power at thirty per cent cutoff, and a maximum of 3,000 horse-power. They will, however, be built strong enough to work under 200 pounds steam pressure.

When running with the most economical load they will require not more than thirteen and one-half pounds of dry steam per indicated horse-power, including the steam used in the reheater, while the steam variation from no load to full load will not exceed three per cent from the normal. Under any change of load the internal variation of speed will not exceed one-quarter of one geometrical degree from the position of uniform rotation.

The design of the engines is a most pleasing one, and the massive construction of the parts will at once impress one upon an examination of the outline drawing.

The bed-plate of two heavy iron castings securely held together by shrunk links, and containing the main bearings, which are of as convenient a kind as any we have recently seen. They are designed with a loose lower box carrying a cast-iron liner without flanges, but recessed into the box by a circular projection, making it secure against end movements, and readily removable by raising the shaft but slightly. The bearings are all lined with babbitt metal, hammered into place, bored and scraped to fit the shaft. The outer bearing extends down to the floor line, resting upon a heavy sole-plate, and is of the self-oiling type.

The shaft is of open-hearth forged steel, having a single-arm crank on the high-pressure end and a double-arm crank on the low-pressure side, which are of open-hearth cast steel and counterbalanced to offset the weight of the reciprocating parts. All of the pins, the eyes for which are bored by special machinery after the discs are in place on the shaft, thus ensuring their accurate alignment, are of forged steel, and, like the journals, are ground and polished. The double-arm crank is provided with an adjustable crank-pin to compensate for any inequality in the wearing down of the main bearing boxes.

The flywheel is twenty feet in diameter, and weighs, with the armature sleeve, close to 125,000 pounds. It is made of cast-iron segments, securely held together at the rim by T-headed shrunk links, and at the hub by means of fitted bolts through the armature sleeve. The rim has segments of cast steel on either side, which lap the joints in the cast-iron rim and are secured to it by through rivets. The armature sleeve is bolted directly to the spokes of the generator, thus relieving the shaft of any strain between the flywheel and generator.

The housings, of the bell type now used largely by the foremost engine builders, are graceful in design and substantial in construction, affording a large area for the cross-head guides and carrying the cylinders on the upper end. The connecting rods are solid at the cross-head end and of the marine type at the crank-pin end, while the cross-heads are of cast steel with adjustable babbitted shoes.

Cylinders and heads are all covered by neat metallic lagging over the non-conducting material.

The system of draining the cylinders and chests of any water when starting up has been carefully studied, and the result is shown in a simple arrangement of an excellence rarely reached in vertical engines. Any or all drains can be opened from the ground level by the movement of levers conveniently placed. The throttle valve also is interesting in design, being capable of slow opening or closing by the usual hand-wheels, or of being instantaneously closed by the throwing of a single lever.

Economical distribution of steam is accomplished by means of double-ported Corliss valves, thus reducing the travel to a minimum, and are actuated by separate steam and exhaust eccentrics on both the high and low-pressure side. The dash-pots are of a reliable type, and are claimed by the builders of the engines to be absolutely noiseless.

These engines, as indeed all engines for sixty-cycle, three-phase generators recently built by the Southwark Foundry and Machine Company, use the King regulating device for readily synchronizing the machines. The operator on the switchboard sends current at will through a small motor which acts as a governor counter-weight, thus enabling him to vary to any extent the speed of the engine.

The governor is of the well-known Porter type, and controls the cutoff on both the high and low-pressure cylinders. It is driven by steel-cut spur gears direct from the main shaft of the engine.

In constructing the pistons care has been used to obtain the simplest construction consistent with the most recent practice, and the hollow form with sectional packing rings set out by springs was finally adopted.

The reheating receiver has a reheating surface which appears tremendous when compared with the short tubes in some of the reheaters we have recently described, but the builders claim that this is absolutely necessary if the steam economy is to vary but slightly under all conditions of load.

The total weight of each engine is about 500,000 pounds, and the dimensions of the principal parts are as follows:

| | | |
|---|---|---|
| Main bearings, inner | 18 × 24 | inches. |
| " " outer | 22 × 40 | " |
| Outer " | 30 × 30 | " |
| Crank pin, H. P. | 12 × 10 | " |
| " L. P. | 15 × 10 | " |
| Crosshead pins | 9 × 10 | " |
| Piston rod | 6½ | " diameter. |

The physical and chemical characteristics of materials used in the engines are those specified by the Southwark Foundry and Machine Company in all of their engines, and, being very rigid, ensure the highest quality of materials.

A Bulkley condenser is provided with each engine capable of condensing 24,000 pounds of steam per hour, and maintaining a vacuum of twenty-six inches when supplied with cooling water at seventy-five degrees Fahrenheit. The usual automatic free exhaust valve and connections are placed in the exhaust pipe of each engine, and a Wainwright feed-water heater, suitable for 1,800 horse-power, fitted with corrugated copper tubes, is connected to each engine exhaust pipe.

The exhaust pipes are galvanized sheet-iron pipe, and extend from the top of the automatic relief valves, near the con-

denser, through the roof, surmounted with standard exhaust heads. The feed water is taken from the hot well or from the city water connections and is handled by two duplex outside-packed plunger pumps, with two twelve-inch diameter high-pressure cylinders, two eighteen-inch diameter low-pressure cylinders, four nine-inch diameter single-acting water plungers with a common stroke of eighteen inches. These pumps are to work against 250 pounds water pressure and either is sufficiently large to handle the entire installation. They were furnished by Thomas A. Lewis. From the pumps, feed water is taken through the primary heaters, located in the exhaust pipe between the engine and condenser, then to the secondary heater, where it is heated nearly to the boiling point, and thence into the feed mains which run along underneath the boilers immediately in front of the ash-hoppers, where connections are made to the vertical lines at the side of the boiler, as mentioned before.

Both the primary and secondary heaters were furnished by the Taunton Locomotive Manufacturing Company, and are of the Wainwright evenflow type with corrugated copper tubes. There are six primary heaters and two secondary heaters. The feed-water piping is of the same extra heavy type as the high-pressure steam piping, and the heaters and pumps are specially designed to meet the company's specifications.

CONDENSING WATER.

The penstock of the old station serves as a supply pipe for this water, a twenty-four-inch nozzle being placed on the side of the penstock near the forebay and two twenty-inch connections, fitted with valves and strainers, are branched into one 20-inch pipe, which runs along the station wall obliquely to a point just below the third mezzanine floor on either side of the engine room. Here sixteen-inch pipes are carried along the mezzanine, reducing to twelve inches and ten inches at the various engines. The injection pipes are taken from this main and are properly provided with injection valves, operated from the floor, and small mesh strainers. The water from the hot wells overflows into a large cast-iron overflow pipe, which runs underneath the hot wells north to the northerly wall of the station on each side of the engine room, discharging either into the tail race of the old station or through underground pipes to the flat on the bank of the river to the east of the station where settling and purification tanks may be installed.

The steam lines to the pumps and exciter engines are taken from a six-inch vertical pipe, which drops from the main on the north side of the station to a small separator in the basement. All of the auxiliary exhaust steam passes through the secondary heaters, and includes the steam from the four stoker engines, the steam from the two feed pumps, two exciter engines, with enough steam from the receiver of the main engines to heat the feed water to the desired temperature for maximum economy.

In addition, the exciter engines are designed so that they may be worked condensing in order to get the greatest overload capacity possible to the engine, in event of a breakdown.

The entire piping installation is to be an example of the best practice in piping, and every precaution has been observed to get a thoroughly tight and satisfactory system. The flanges are of the new extra heavy standard, and all fittings and valves are special in their type to suit the very severe conditions under which they will work. The details of the flanges, fittings, valves and of the bent pipe have been carefully worked out and the maintenance charge of the system will be extremely small. The piping contractors are Messrs. Howe & Bassett, of Rochester.

ELECTRICAL EQUIPMENT.

The generating apparatus consists of six 1,360-kilowatt,2,500-volt, 2-phase, 60-cycle, 90-revolution-per-minute, steam-driven generators, installed in the main station, and three 350-kilowatt, 2,500-volt, 2-phase, 60-cycle, water-wheel generators, direct-connected to three turbines, installed in the adjoining station, transformed into an extension of the main operating room. The 1,360-kilowatt steam-driven generators, which are of the revolving-field type, are designed to carry full rated ampere load and voltage, with a power-factor of eighty per cent, and also to carry at rated voltage twenty-five per cent ampere overload at ninety per cent power-factor, for three hours, or fifty per cent ampere overload at ninety-five per cent power-factor for one hour, after a continuous full-load run, without heating more than sixty degrees centigrade (by resistance) over the surrounding air. The water-wheel generators of the inductor type have also a liberal overload capacity and low heating limit. The excitation of the present generators is provided by two steam-driven 75-kilowatt, 125-volt, direct-current exciter sets; but later an induction motor exciter will be added to supplement the steam-driven exciters. These were installed first on account of the greater reliability for continuous service, the excitation of the generators being thereby made independent of any electrical disturbance which might affect the regular operation of the system, and also on account of the relatively high economy realized by utilizing the exhaust steam to heat the boiler feed water, as this station has no other steam auxiliaries except the boiler feed pumps and stoker engines.

In this station will also be installed three 500-volt motor-generator sets to replace the old equipment in the old station and to provide new capacity for this service. These motor-generator sets consist of two sets of 250-kilowatt and one set of 500-kilowatt 500-volt compound-wound generators, direct-driven by 2,200-volt synchronous motors. The motor-generators will be started from the direct-current side, and to provide direct current. In case of shutdown of the 500-volt direct-current supply, a 50-kilowatt 500-volt direct-current generator has been installed at one end of one of the exciter engine shafts furnished with a coupling. This small generator will also be used to carry light loads as well as for occasionally starting the motor-generator sets.

All electrical connections of generators and exciters, etc., are brought to the operating switchboard on the gallery, running east and west on the south side of the station, and having lateral extension on the east wing of the station. On this gallery and at the centre, facing the centre aisle of the operating room, are placed the nine generator panels, with instruments and switching gears on the front of the panel and two sets of busses, with transformers, etc., on the back. The main switches are single-throw oil switches, with an independent oil tank for each of the four legs of the two-phase circuit. From the oil switch the circuit is brought to a specially designed two-bus knife-blade selector switch mounted on top of the panel and operated by a system of gears and levers controlled from the front of the panel. These switches make connections to the two independent sets of bus-bars and enable one to operate different generators on different bus-bars whenever it may be desirable to do so to ensure the continuity of service of the whole system. Each generator panel is equipped with two alternating-current ammeters, one alternating-current voltmeter, one field ammeter, an indicating wattmeter, a ground detector and a synchronizer consisting of two transformers, one on the machine side and one on the bus side of the oil switch, with two synchronizing lamps and a switch in series, as well as

generator and field switches and an overload relay. The field rheostats are located on the mezzanine floor below the operating switchboard with rheostat dials clamped to iron beams below, with pedestal and controlling-wheel mounted above in front of each machine panel, and within easy reach of the operator.

On the east side of the machine panels are mounted the exciter panels equipped with ammeters, voltmeters, ground detectors, field rheostat dials, etc., and necessary switches. After the exciter panels come the alternating-current lighting single-phase panels with two circuits to each panel. Each circuit has a double-throw oil switch, one ammeter and two expulsion fuse blocks. At the extreme end and on the bend along the eastern wing of the gallery is provided ample space of 4,000 alternating-current series arc lamp panels.

At the west side of the generator panels are mounted four power panels controlling four two-phase high-tension cable feeders transmitting 2,500-volt two-phase current to the direct-current motor-generator substation. For safety, as well as for economizing space and to bring all apparatus within easy supervision of the switchboard attendant, two electrically operated oil switches, one for each set of busses, have been adopted for these power panels, on which are only mounted two ammeters, one power-factor indicator, one polyphase wattmeter, one overload time-limit relay and a set of small switches controlling the two electrically operated oil switches erected on the mezzanine floor below. On the same panels are also mounted synchronizers which allow to synchronize and close both switches at the same time, thereby tying together the two busses. The load can then be shifted from one bus to the other bus, and the first set of switches opened thereby disconnecting the substation from one set of busses without disturbing their operation. Under normal operation, however, the two oil switches on the power panels will be interlocked so as to prevent unintentional closing of both switches at the same time.

Following the substation power panels there are two power panels for the 500-volt motor-generator sets installed at the station. Also for these panels electrically operated oil switches, mounted on the mezzanine floor below, have been adopted, and on the panels are mounted the main 500-volt direct-current switches and field switches, the small starting switch, the switches controlling the electrically operated oil switches, the synchronizing lamps and also alternating-current ammeter, power-factor indicator, direct-current ammeter, time-limit relay and direct-current circuit-breaker. The instruments and switching gears of the two 250-kilowatt units are mounted on one panel and the 500-kilowatt unit, with the fifty-kilowatt starter and motor-generator starting switch, is controlled from the second panel. Field rheostats and dials are on the floor below and are operated from stands in front of the panels.

The 500-volt direct current passes then through a totalizing panel with ammeter, wattmeter and ground detector, and feeds three direct-current feeder panels, two circuits on each panel, each circuit being equipped with knife switch, circuit-breaker and ammeter.

From the switchboard gallery all wiring is carried in suitable ducts and cable racks to the large manhole in the street outside the station and from this point the cable circuits are carried underground to the central section of the city, or to the other sections of the city where overhead distribution is used.

The substation power feeders are made up of paper-insulated, lead-covered duplex cables, drawn into tile ducts, with manholes at every street intersection. There is now only one substation, located at Minerva place, near Main street, and at the centre of distribution of the business section. The substation was a manufacturing building, of which only the basement and first floor have been used for the substation, leaving the tenants above undisturbed. In this substation are now being installed two motor-generator sets, consisting of one 500-kilowatt synchronous motor, operated from the 2,200-volt two-phase supply and driving two direct-connected, 250-kilowatt, 135-volt, 360-revolutions-per-minute, direct-current generators. In addition a small seventy-five-kilowatt motor-generator set is installed, to be used as a starter as well as to operate at light loads.

All switchboard apparatus is mounted on the same gallery, running lengthwise one side of the building. At one end are the machine panels, with oil switches, bus-selector switches, instruments and synchronizers and overload time-limit relays. At present there are no feeder panels, the machine panels being now used also as feeder panels, the feeders being connected to two sets of bus-bars, from either of which any machine can be operated by means of the bus-selector switches. Field rheostats of motors are installed underneath the gallery and rheostat dials are controlled from the front of the switchboard.

The low-tension direct-current switchboard, separated from the high-tension switchboard by heavy soapstone barriers, is divided into three sections in this order: First, the neutral bus, from which the operation and regulation are accomplished; second, the positive outside pole switchboard for generators and low-tension feeders; third, the negative outside pole switchboard for generators and low-tension feeders.

On the neutral switchboard are mounted the main neutral switches, field switches and starting switches, with field rheostat dials, ammeters, galvanometers, station voltmeter and standard feeder voltmeters.

The outside pole switchboards have two sets of bus-bars which can be tied together, and each feeder is equipped with an ammeter.

The low-tension feeder cables drop from the feeder switchboards and, properly racked, are brought to the cable vault, where connections are made to the underground cable feeders. They are drawn into subway ducts and brought to the intersection of Minerva place and Main street, where they branch out in different directions, in the existing subways, reaching out into the heavily loaded districts in this section of the city.

The company is now using concentric cables of 1,000,000 c. m. sectional area for each conductor, with six pressure wires for feeders and 350,000 c. m. and 200,000 c. m. single conductor cables for mains. The neutrals are now of 350,000 c. m. section, but 1,000,000 c. m. cable will also be used. All low-tension cables are paper-insulated and are designed for a working pressure of 750 volts direct current.

It may be wondered at at first that a steam generating plant of this size and importance should have developed in this section where water power is at times so plentiful, but the parties responsible for this enterprise are very confident of the advantages of steam generation over water power, basing their claims first, on the fact that water power is uncertain and inadequate at certain periods, which makes it necessary to install an auxiliary steam plant of equal capacity to the water plant, thereby adding expense to the investment account, as well as to the production cost; second, that the water power has to be utilized at several stations which is detrimental to the economy of operation; third, that the steam plant and the water plants require duplication of station apparatus and transmission lines; and fourth, that in a highly efficient steam plant with the price of coal as low as it is in Rochester, the saving of coal is a small factor of the total cost of production and distribution.

The entire plant has been designed under the supervision of Mr. Thomas E. Murray, of New York city, who has conferred as to local exigencies with Mr. M. J. Warner, the general manager of the Citizens' Light and Power Company, and Mr. A. Anderson, the operating superintendent of the Citizens' Light and Power Company. A sufficient guarantee of the efficiency and excellence of the plant is furnished by the fact that Mr. Thomas E. Murray has designed in the past such stations as the Kings County Electric Light and Power Company, of Brooklyn, N. Y., of 10,000 horse-power capacity; the Waterside station of the New York Edison Company, with a capacity of 150,000 horse-power; the station of the Equitable Gas and Electric Company, of Utica, N. Y., of 3,000 horse-power capacity, and the Third avenue station of the Brooklyn Rapid Transit Company, of Brooklyn, N. Y., with a capacity of 50,000 horse-power.

The fact that the Citizens' Light and Power Company will generate alternating current at 2,200 volts will result in giving the citizens of Rochester as satisfactory electric service in the outskirts of the town as in the centre, this never having been possible up to the present time.

### The Bremmer Arc Lamp.

There has just been installed in the offices of the Westinghouse Electric and Manufacturing Company, in New York city, a number of arc lamps of the interesting type recently invented by Herr Hugo Bremmer, the American patents for these lamps having beeen acquired by Mr. Geo. Westinghouse. Several of the lamps have also been installed for private outdoor lighting in New York city.

FOUR BREMMER ARC LAMPS AND A COOPER-HEWITT SPIRAL LAMP.

The Bremmer arc lamp, of which a photograph is here reproduced, is of a type widely different from others now in use. In essential construction it consists of a number of carbons, obliquely approaching one another, the arc burning between their lower ends and being held in position by a magnetic "blast." This arc is burned in a cup-shaped chamber into which the ends of the two carbons protrude, and the lamp casts no shadows under the arc. The metal chamber or cup being enameled with white forms also a reflector. The carbons are made in short sections, a number of them being located in a magazine and automatically fed down, so that as one is burned another takes its place. The arc is struck by means of a carbon point on the end of a lever, which, when current is turned on the lamp, is thrown over against the electrode points and immediately withdrawn, leaving the arc established. The mechanism for feeding is of the simplest clutch variety.

The most interesting feature, however, of the lamp is in the nature of the carbons used. The positive and negative carbons differ in size, the positive being the larger, and while the negative carbon is solid the positive is cored and filled with a mixture of carbon powder and metallic salts. In the patent specifications covering the lamp such substances as salts of calcium, magnesium and strontium, fluorspar, glass, etc., are mentioned as appropriate for this purpose. A flux generally consisting of a fluoride is added to this mixture, this preventing the formation of hard cinders which might injuriously affect the burning of the lamp. The inventor states that fluorine in particular, if added to the carbon compound in conjunction with twice its quantity of calcium salts, yields a pleasant yellowish light.

The lamps shown in the foreground are of 4,500 candle-power and consume nine amperes at 110 volts, exhibiting thus an efficiency of about three times that shown by the enclosed arc lamp. The light is a magnificent golden white, resembling afternoon sunshine, and the burning of the lamp is exceedingly steady. The lamp is made also in a smaller size, as shown, consuming six amperes, and giving 2,000 candle-power. In the illustration one of Mr. Peter Cooper-Hewitt's mercury vapor lamps is shown suspended between two of the new Bremmer lamps.

### The Bridging Bell Patents Held Invalid.

In the United States Circuit Court, at Pittsburgh, Pa., on January 27, Judges Joseph Buffington and Mark A. Acheson held that the Carty patents, generally known as the bridging bell patents, were invalid.

The suit was an injunction proceeding brought against the Anthracite Telephone Company, of Williamsport, Pa., by the Western Electric Company. The injunction was refused and the costs were placed upon the plaintiff. The case is in many respects remarkable; the judgment is a reversal, by themselves, of the opinion held by the two judges in a former case of the Western Electric Company against the Millheim Electric Telephone Company. The same judges decided at that time in favor of the Carty patents, their judgment being confirmed by the Circuit Court of Appeals. In his opinion refusing the injunction and placing the costs on the Western Electric Company, Judge Buffington says that he and the United States Court of Appeals would have dismissed the former case had they known that the American Telephone and Telegraph Company, as since developed, owning more than one-half of the stock of the Western Electric Company, bought out the Millheim company, pending the decision.

Judge Buffington, in his opinion, declares that the devices covered in the Carty patents involve no patentable novelty, because the general principles applicable to series and multiple-arc distribution were known and used prior to Carty's invention.

It has generally been felt that these patents, which were issued to Mr. John J. Carty in the year 1891, were the basis upon which the modern telephone exchange business has been constructed.

## Book Review.

**"Simple Electrical Working Models; How to Make and Use Them." 4¾ by 7¼. Fully illustrated. 70 pages. London. Dawbarn & Ward, Limited. Sixpence net.**

This little book is No. 8 in the Model Engineer's Series. The editor, Percival Marshall, has set forth the construction of models in a way which the merest amateur can fully comprehend.

### Side-Cutting and Splicing Pliers.

The Smith & Hemenway Company and the Utica Drop Forge and Tool Company, of New York city, have brought out the convenient tool here illustrated.

It is a Swedish side-cutting and splicing pliers and is made from Swedish electro-boracic steel, which has been tested for years and found to be proper for cutting the hardest kinds of steel and iron wire without affecting the cutting edge.

The tool has a patent round edge, which

Side-Cutting and Splicing Pliers.

is a great advantage, as it can be carried in the pocket without wearing or tearing the clothes. It is also very desirable where there is any liability to drop the pliers on the wire where men are working. Square edges will invariably break the scale, thereby injuring the conductivity of the wire, while the round edge will not. This is also a great advantage in copper wirework. The tool has polished head and jaws, and comes finished in either half-polished, polished or nickeled, and in six different sizes.

### Explosion in the New York Rapid Transit Subway.

At noon, on January 27, a quantity of dynamite or some other high explosive, stored in a wooden building standing at the head of a shaft of the Rapid Transit Subway work, near the intersection of Forty-first street and Park avenue, New York, exploded with disastrous results, wrecking buildings within a radius of several hundred feet, killing six persons and wounding a very large number of others.

This is the first serious casualty that has marked the progress of work on the subway. Considering the difficulties and dangers which have been incident to much of the work, it is remarkable that so great a portion of it has been completed without substantial injury to persons or property before this calamity occurred.

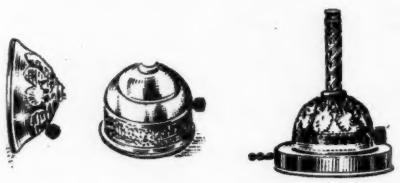
Mr. W. R. Brixey, well known in electrical circles as the manufacturer of Kerite wires and cables, resides in the Murray Hill Hotel. He had been for some days confined to his rooms by illness, and was sitting at a window when the explosion occurred. His head was severely cut by flying glass resulting in a fracture of the skull. At the time of going to press Mr. Brixey was resting easily, and, though dangerously injured, strong hopes for his recovery are entertained.

### A New Dimming Apparatus.

In the beautiful new building of the Lying-In Hospital, in New York city, the electrical appointments are many and interesting. The wards are lighted entirely by electric incandescent lamps, suspended in inverted reflectors, from which the light is thrown upon the white ceiling, producing a softening and pleasing effect. To further increase the comfort of patients a dimming apparatus is placed behind a panel at the entrance to each ward, and

Portable Dimming Lamp Apparatus.

by means of a key in the panel the intensity of the light is reduced through successive gradations to a mere glimmer. The Electric Regulator Company, New York city, has installed this apparatus. The company also uses this apparatus in con-



Various Styles of Canopies for Dimming Lamps.

nection with a portable lamp and with any form of bracket, as the illustrations fully set forth. The company claims advantages for the apparatus on the following features: The use of any ordinary lamp is permissible, the gradations are controlled by step-by-step contacts into a resistance tube in the canopy, the increase in temperature being very slight, and the entire effect from zero to full light is regulated by a single key in the canopy.

The annual convention of the Wisconsin independent telephone companies will be held in Milwaukee, Wis., February 19 and 20.

### Railroad Wire Fences for Telephone Use.

To the Editor of the Electrical Review:

Perhaps it would be of interest to independent telephone people to know that the right-of-way wire fences of the various railroad companies can be used for telephone purposes, giving, on short distances, as good service as could be desired. I have been using such a line for over a year and have found the service of the best, with very little trouble. A tip to the bridge or section gangs working such sections of track along the road where the wire fence is used is usually all that is necessary to keep the wires in perfect shape. If a metallic circuit is wanted the top wire of each fence on the two sides of the railroad track should be used. At all crossings the wire should be raised from the fence and "poled" over the crossings at least fourteen feet above the ground to allow the free passage of all hay wagons, and at culverts and cattle-gaps the same plan should be used. The fact that the wire touches many posts seems to bother very little in the working of the line.

A good help to projectors of such fence lines is a railway attachment to an ordinary bicycle which enables him to run over his line rapidly, seeing any defect from his seat on his wheel while on the track, and as the trouble is usually a stray wire thrown across the fence it is easily mended. These railroad fences are usually kept in the best of repair by the section hands, and I can not see why the railroad companies do not use the wires themselves between stations.

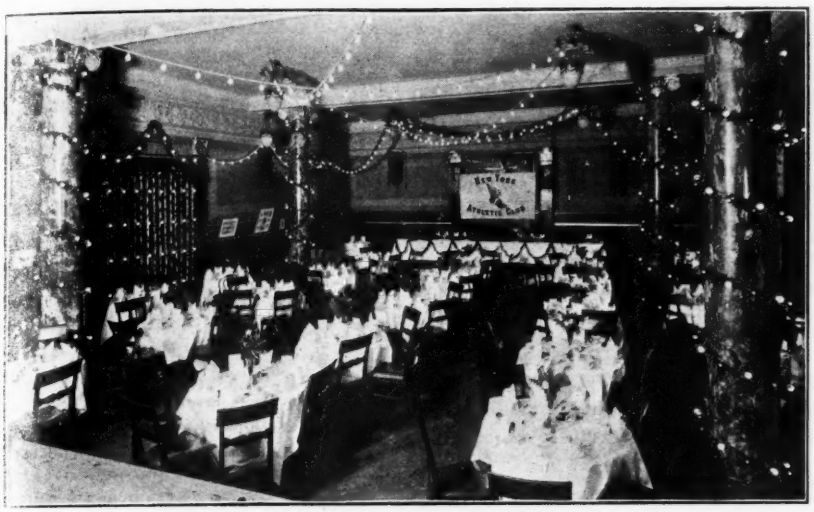
In dry weather these wires can be used with good service up to a hundred miles, cost little to operate and give good satisfaction. Another and perhaps better plan is to run an extra wire with brackets on top of the fence posts, touching posts about every 180 feet, bridging the crossings as before. The trouble from such lines is not apt to be any more than on the ordinary cheaply constructed country long-distance line, as the fence posts never fail, the wires are looked after by the section men, and should people go through the fence they usually replace the wires as they were. I had a line some twenty miles long down in Texas, which I used both for telephone and telegraph purposes at the same time and which gave good satisfaction. I notice the Illinois Central is going to equip its stations with telephones, which will doubtless be a great help to them. A full investigation of connecting telephones to railroad telegraph wires would surprise and please many over the good results they could obtain in this way when properly handled.

T. P. Martin, Jr.

Marlow, I. T., January 20.

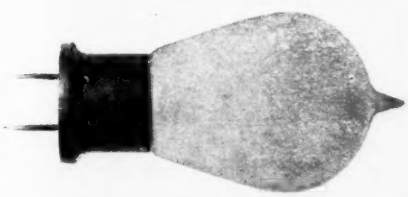
**Display and Decorative Lighting.**

The manipulation of small incandescent lamps for purposes of decoration and publicity has rapidly become a feature of cities, large and small, and considerable progress is noted in this line of electrical industry. Among recent developments in this direction, the "Elblight" system, controlled by the National Electric Improvement Company, New York city, seems worthy of consideration.



Banquet Room—Festoons and Wreathing Lamps.

Simplicity of construction, together with what appears to be an indefinite range of operation, is the chief feature of this system. Two forms of apparatus are used, that of board or sign lighting and of flexible cable, in both of which, however, the one type of lamp, as shown in the illustration, is used.

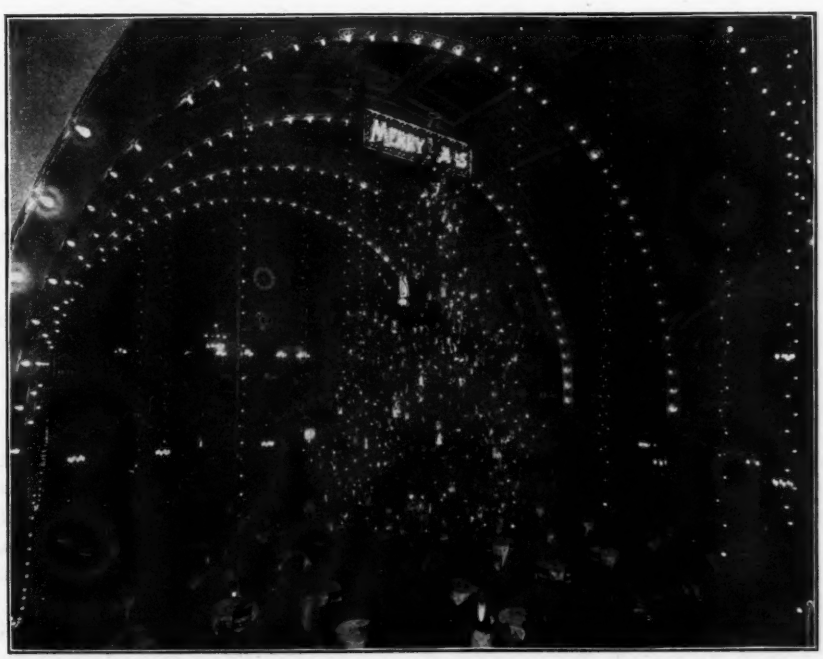


Lamp Showing Pointed Terminals.

In the system of board lighting, the conductors are carried in parallel strips, being insulated with a high-standard, self-healing Para rubber compound and entirely covered with a cork mat. Metal flanges are affixed to the edges of the boards, and any design of advertising may be made up on a removable pasteboard, and the lamps adjusted, the sharp pointed copper terminals being easily pushed through the cork mat and making contact with the finely meshed conductors through the insulation. The boards are adapted to either interior or exterior lighting, very severe tests having shown them to be impervious to water, and also giving a high percentage of illuminating efficiency. Another form of the lighting board is for use with table candelabra, a portion of the table being either countersunk or built up to accommodate the conducting mat. A detachable pin socket is pressed through the tablecloth, and the candelabrum is connected with a pivot contact, allowing it to be moved or turned as desired.

The two large illustrations show the adaptation of the flexible cables to decorative work. Twin cables are strung side by side, carrying 300 fine wires that form an aggregate capacity equivalent to that of a No. 5 B. & S. gauge wire. These fine wires are braided in a peculiar manner, which gives the cable great flexibility, and permits the free insertion of pin terminals without causing any disruption of the fine strands. This cable is insulated with the self-healing compound and also protected from mechanical injury by a braided covering and weather-proof coating. This cable, after submersion in water for forty hours, withstands a remarkable breakdown pressure and on the galvanometer shows a high resistance.

This system has been successfully operated in a number of prominent installations. The artist's creative fancy seems to be the limit to which the decorative effect can be carried. With parti-colored and variegated bulbs wonderful effects are produced, and unadorned rooms on interior occasions, or trees and canopies in outdoor fêtes, may be transformed in an amazingly short space of time.




Christmas Tree Illumination. Two Thousand Lamps Installed in Three Days.

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The questions as to whether a college education is an advantage to a young man in the practical work of the world is answered in the affirmative in the current number of *The Popular Science Monthly* by Professor Thurston, dean of the Sibley College of Engineering of Cornell University. He argues that hereafter the uneducated man will not have such opportunities as he has had in the past. Even now the chances in favor of the college man are as thirty to one, and Professor Thurston believes that he will come more and more generally to take and to hold one hundred per cent of the positions assigned the generals in the great army of industry.

# Chicago Electrical Notes.

(By Our Special Correspondent.)

THE power-house and cars of the La Salle street railway were completely destroyed on the night of January 14 by a fire which originated in one of the car stoves. It is said that plans had been arranged to transfer the road to a company of Ohio capitalists. It is not known what effect the fire will have on this sale.

The Enterprise Heat, Light and Power Company, of La Salle, Ill., which recently constructed a plant consisting of a sixty-kilowatt Western Electric generator, 220 volts, with compensators moving a three-wire system, has sold its property to the Peru & La Salle Gas and Electric Light Company, of La Salle. The latter has also purchased the old company's plant which has been doing business in La Salle and will now construct a new electric light plant. Ground has already been broken.

Joseph A. Gaboury, a prominent electrical engineer and traction official, of Greenville, Miss., was in Chicago on business last week. Mr. Gaboury says the South is prospering and that it promises great development along electrical lines during the coming decade. Mr. Gaboury was one of the pioneers in the electric traction field, and built and operated one of the first—if not the first—successful electric railways in the United States, at Montgomery, Ala., in the eighties.

Judge Tuley last week made permanent his temporary injunction against the Chicago Telephone Company, which forbids it charging more than $125 per annum for service. It will be remembered that the telephone company had advanced its rates because of improvements which it claimed to have made at great expense. The city ordinance fixes the maximum charge at $125 and Judge Tuley holds that the company must not disregard this law. It is probable that the case will go up to a higher court.

The Automobile Show, which will be given under the auspices of the Chicago Automobile Club and the National Association of Automobile Manufacturers at the Coliseum, March 1, promises to exceed the most ardent expectations of its promoters. Not less than 125 concerns will exhibit their machines, and these exhibits will come from all sections of America and Europe. Space is in such great demand that the track, which was left clear on the main floor last year, will be used by exhibitors this season. Famous automobilists of Europe have notified the managers that they will attend.

The Central Electric Company, of La Crosse, Wis., began the operation of its new plant in that city on January 15. The officers of the company are R. B. Gelatt, president; William Doerflinger, vice-president; C. J. Felber, secretary; Jno. A. Elliott, treasurer. The stockholders of the company include more than seventy business men of La Crosse. The equipment of the power station consists of four dynamos of 800-light capacity each, making 3,200 lights altogether, manufactured by James Clarke, Jr., & Company, of Louisville, Ky.; two 150-horse-power steam engines, made by McIntosh, Seymour & Company, of Auburn, N. Y.; three 150-horse-power boilers, made by the Henry Voght Machine Company, Louisville, Ky. The plant starts out with strong competition from the old company in La Crosse, but its promoters are confident of success.

Both City Electrician Ellicott and City Engineer Ericson have taken a hand in the agitation for a better street car service in Chicago. The former is back from a trip to eastern cities, where he has been making a study of the underground trolley systems of New York and Washington. Mr. Ellicott says that Chicago is away behind the times so far as its traction lines are concerned. He affirms that New York and Washington have found the underground trolley not only practicable but eminently satisfactory and far superior to the cable, which is causing such annoyance on the streets of Chicago. He will advocate the fixing of a certain territory in the crowded districts of the city in which the underground trolley must be installed. He believes there are no adverse conditions here which can not be overcome and says that Washington had greater difficulties to overcome than Chicago would have in adopting the underground trolley. He estimates that the cost of changing from the cable to the trolley would be $50,000 per mile. City Engineer Ericson has made an inspection of the North and South Side cable lines and reports that the service is unsatisfactory. He reports the power-houses in first-class condition, but says that the strain on the cables is greater than they can bear, resulting in numerous breakdowns. Larger cables, he says, would not be practicable with present apparatus. He makes the following interesting statements in regard to the life of the cables used on the various lines: Life of State street cable, from Twenty-first street north and back, ninety days; life of State street cable south, from Twenty-first street to Thirty-ninth street, ten months; life of Wabash avenue cable from Twenty-first street north, ninety days; life of Cottage Grove avenue cable south, from Twenty-first street to Thirty-ninth street, ninety days; life of State street cable south, from Thirty-ninth street to Fifty-second street, 300 days.

Chicago, January 25.

### Motive Power from Waste Gases.

The production of motive power from blast-furnace gases formed the subject of a paper by Mr. Bryan Donkin, recently read before the (British) Institution of Civil Engineers. Only within the past few years has it been realized that power can be produced economically and effectively by utilizing the gases from blast furnaces to drive gas engines. As the annual production of iron from blast furnaces throughout the world is 40,000,000 tons, this new application of motive power is capable of immense development. The gases given off from these furnaces during the process of smelting iron are practically the same as weak producer gas. Until about half a century ago they were all wasted. A part was next utilized under boilers to generate steam to drive the blowing engines and part to heat the air blast; but after supplying these requirements a considerable surplus was available. Successful efforts have been made, first to use this surplus in gas-engine cylinders to obtain power, and next to discard steam engines, boilers and chimneys entirely, and utilize all the gas in this way. A great impetus has been given to the construction of large motors by the discovery that blast-furnace gases can be used to drive them. They are now made in sizes up to 1,000 horse-power and 1,500 horse-power, and still larger powers are in contemplation, while the difficulty of starting these large engines has been successfully overcome. Mr. Donkin gave some account of the very rapid progress made in this class of work on the Continent. Many of the large firms in Germany and Belgium are now busily employed. The Gasmotoren-Fabrik Deutz has numerous orders for motors from 500 horse-power to 1,000 horse-power, while at Seraing, in Belgium, an aggregate of 39,000 horse-power has been bespoken. Messrs. Körting, of Hanover, have also supplied several engines, and the Deutsche Kraftgas-Gesellschaft propose to construct motors up to 1,500 and 2,000 horse-power. It was remarked that England and Scotland seem rather slow to utilize these gases.

# CURRENT ELECTRICAL NEWS

## COMMERCIAL NEWS

### DOMESTIC AND EXPORT

STREET RAILWAY MERGER—The Cleveland & Eastern, the Cleveland & Chagrin Falls, and the Chagrin Falls & Eastern Electric railways, it is said, will be merged into one company to be known as the Eastern Ohio Traction Company, with a capital of $2,500,000.

MILLION DOLLAR TELEPHONE COMPANY—The Star Telephone Company was incorporated at Albany recently with a capital stock of $1,000,000. Its charter permits it to maintain telephone and telegraph lines from New York to Albany, Boston, and intermediate cities; also upon Long Island and from Jersey City to Philadelphia.

MORE ELECTRICAL SUPPLIES FOR AUSTRALIA—The central power station of the Sydney City & Suburban Tramways, of Sydney, Australia, the initial equipment for which contracts to the extent of over $1,000,000 have already been placed in this country, is to be considerably extended in capacity, and an expenditure of some $500,000, it is expected, will be incurred very shortly.

TELEPHONE COMPANY REPORT—Gross earnings of the Chicago Telephone Company for the year 1901, as shown by the reports made at the annual meeting of stockholders recently, were $3,775,001, a gain of $645,763 over 1900. Operating expenses amounted to $2,691,129, an increase of $432,349, leaving net earnings of $1,083,872, a gain of $213,415. On the average capital of $8,000,000, dividend earnings were at the rate of 13.55 per cent.

EVERETT-MOORE HOLDINGS MAY BE SOLD—Representatives of the Elkins-Widener Syndicate have examined all the traction interests of the Everett-Moore Syndicate with a view of purchasing the latter's extensive interests. The Elkins-Widener agents are well satisfied with the physical condition of the traction lines and consider them a desirable investment. It is now practically settled that either the Federal telephone system or the entire traction system will be sold in a lump. The sale of either property will eliminate the necessity of selling the other. C. W. Morse, of New York, may buy the telephone lines.

AMERICAN DISTRICT TELEGRAPH COMPANY SETTLEMENT—Agreement has been reached between the conflicting stockholders in the American District Telegraph Company. The plan of the Western Union men to reduce the capital stock of the company from $4,000,000 to $2,000,000 was defeated by a small vote of the stockholders, but the Western Union officers of the company were reelected. General Eckert's annual report to the company shows that the total income for the year was $630,701.68; the total expenses, $527,282.02, leaving a total net revenue of $103,419.66, which, with a cash surplus on December 31, 1900, of $80,503.65, leaves a total surplus of $183,923.31. The company paid dividends during the year 1901 of $96,107.50, leaving a net surplus on December 31, 1901, of $87,815.81.

A NEW TELEPHONE SYNDICATE—The Western Telephone and Telegraph Company, with an allowed capital of $32,000,000, and the Occidental Telephone and Telegraph Company, with a capital of $5,000,000, have been incorporated in Trenton, N. J. The first was incorporated by Chandler Hovey, George E. Perrin and Albert T. Walker, of Guttenburg, N. J., and Elmer H. Geran, of Matawan, N. J., and the Occidental company by the same persons, together with Russell Robb, Horace Rogers and Henry R. Hazen, all of Boston. The capital of the Western company is to be divided into $16,000,000 of preferred stock, calling for six per cent non-cumulative dividend until February, 1904, and then become cumulative, and $16,000,000 of common stock. Both companies are chartered under the act of 1896, thus authorizing their operation outside of New Jersey.

BRITISH TENDERS IN THE MARKET—The Gas and Electricity Committee of the city and county of Belfast is in the market for the supply of cable, the laying of same and the supply of earthenware conduits. The Tramway Committee of the Cardiff (South Wales) corporation is in the market for the supply, delivery and erection of two 1,600 inducted horse-power vertical compound condensing engines, fitted with Corliss valve gears and two 900-kilowatt generators, to be mounted direct into the shafts of the engines. The Glasgow corporation invites tenders for the supply of material in connection with the equipment of the overhead construction of its electric traction system extension. It will be recalled that practically all the equipment for the original system of that Scotch city was purchased in the United States.

TORONTO MONEY IN BRAZIL—It is somewhat over a year since local interests formed the Sao Paulo Tramway, Light and Power Company, Limited, and at the second annual meeting of the company, held in this city recently, it was shown that the enterprise is making satisfactory progress. At this date the power plant at Parnahyba Falls has been completed, with a present capacity of 6,000 horse-power, readily increasible to 10,000 horse-power. Thirty-five miles of electric tramways are in operation, with thirty-three motor cars, having an average earning ability of $44 per car per day, the gross income of the tram system for the past six months, *i. e.*, during its conversion, was $491,508, and the operating expenses were $300,739, leaving a net income of $190,769. It is estimated that, were the tramway system entirely converted to electricity, and were the Agua e Luz (lighting company) transferred to the new management, the returns for a year would (based on last November's earnings) be as follows: Gross income, $1,044,914.04; operating expenses, $285,659.88; net income, $759,254.16.

## PERSONAL MENTION

CAPTAIN WILLARD L. CANDEE, managing director of the Okonite Company, New York, returned last Sunday on the Umbria from a short vacation abroad.

MR. A. E. DOBBS, who has been contributing considerable literature on the subject of telephony recently, was married on January 7 to Miss Cora M. Dodge, at Ravenna, Ohio. Mr. Dobbs's many friends in the electrical industry are still expressing their felicitations.

MR. HENRY H. SYKES, of St. Louis, Mo., has been appointed general superintendent of the Southern New England Telephone Company, to succeed Mr. E. B. Baker, whose resignation will take effect May 1. Mr. Sykes is now connected with the Missouri Bell Telephone Company.

SIR WEETMAN D. PEARSON, president of a British contracting concern which is building the Tehuantepec Railway and other important construction in Mexico, has arrived in New York and will stop at the Waldorf-Astoria for a few days. The Pearson company is a large purchaser of United States material for utilization in its Mexican undertakings.

MR. WILLIAM MARCONI has been honored by the King of Italy, receiving the decoration of the Order of St. Maurice and St. Lazarus. Mr. Marconi sailed from New York last week, and for thirteen hours kept up a conversation with a representative on board the steamer La Savoie lying in her pier in New York city, from the outbound Philadelphia on which he sailed.

MR. NEWCOMB CARLTON has been elected vice-president of the Bell Telephone Company, of Buffalo, succeeding Colonel David B. Parker, who has resigned on account of ill health. Mr. Carlton was formerly the director of works at the Pan-American Exposition, and is a gentleman of fine executive ability and energy, and will be a valuable addition to the staff of the company. Mr. Joseph F. Baecher has succeeded Mr. William H. Watson, resigned, as secretary and treasurer of the company.

MR. B. H. WARREN, second vice-president of the Westinghouse Electric and Manufacturing Company, resigned last week on account of ill health and was succeeded by Mr. F. H. Taylor, who has been fourth vice-president of the company and head of the sales department. Mr. Taylor is a Harvard man and has been identified with the Westinghouse company since 1896. Mr. Warren, who has been in poor health for some time, will take a long rest, but still remains a director of the company. Mr. L. A. Osborne, who has been manager of the Westinghouse works at East Pittsburgh, succeeds Mr. Taylor as fourth vice-president.

## ELECTRIC RAILWAYS

MILWAUKEE, WIS.—A franchise has been asked to build a new electric railway from Port Washington to Milwaukee.

FRANKLIN, IND.—The county commissioners have granted a franchise to the Indianapolis, Nashville & Southern Transit Company.

FREEPORT, ILL.—The highway commission has granted permission to the Rockford & Freeport Electric Railway to construct and operate its line.

TORONTO, ONTARIO—The Huron & Bruce Railway Company has asked for incorporation and will run from Wiarton, on Georgian Bay, to Goderich.

CITY ISLAND, N. Y.—It is reported that the Metropolitan Street Railway Company has bought the Bartow & City Island Railway, at a cost of $250,000.

RICHMOND, IND.—The city council has granted a franchise to the Hamilton, Eaton & Richmond Traction Company. Work is to begin July 1, 1902.

NASHVILLE, TENN.—A right of way has been granted L. H. Davis and associates to construct a street railway through certain West Nashville roads.

COLUMBUS, OHIO—A new company has been organized with sufficient capital to build the electric road from Columbus to Urbana and Mechanicsburg.

SELLERSVILLE, PA.—The Lehigh Valley Traction Company has decided to build a large central power station at Sellersville, and work will begin at once.

GREAT FALLS, MONT.—A long electric railway is to be projected during the coming summer between Missoula and Hamilton. Work will begin in the spring.

DEADWOOD, S. D.—The city council of Deadwood has been asked to grant a franchise for an electric car line, connecting Deadwood, Central City and Spearfish.

CLINTON, N. Y.—The construction of the electric railway from Clinton to Utica has now been completed and traffic begun. The railway has been constructed in four months.

CHURCHVILLE, N. Y.—The village trustees have granted the Buffalo & Williamsville Railway Company a franchise to construct and maintain a double-track electric railway.

PARIS, TEX.—Mr. W. J. Kilpatrick, of Cleveland, Ohio, has asked the city council for a franchise and right of way on certain streets to build an additional electric railroad line.

GREENVILLE, OHIO—The Greenville city council has granted a franchise to the Richmond & Greenville Traction Company to build, operate and maintain an electric line in this city.

ALBANY, N. Y.—The Rochester, Syracuse & Eastern Railroad Company has asked the railroad commissioners for authority to construct an electric road from Rochester to Syracuse, over 100 miles.

KENNETT SQUARE, PA.—The Vandergrift Construction Company, of Philadelphia, has given bonds to have an electric road in operation from Oxford to Kennett Square within two years.

AURORA, ILL.—It is understood that there is now plenty of money to back the enterprise and the electric railroad to De Kalb and Rockford will be built for at least twenty-four miles.

AMBLER, PA.—A temporary power-house is to be built just outside of Ambler by the Philadelphia & Lehigh Valley Traction Company. It is expected that the contract will be awarded shortly.

NORTH COHOCTON, N. Y.—A franchise has been granted by the town of Bath, which completes the right of way through all the towns between Elmira and Rochester. Work will begin about April 1, next.

CLEVELAND, OHIO—The city council has passed an ordinance establishing new street railroad routes reaching to all parts of the city and authorizing the Mayor to advertise for bids for franchises over these lines.

DAYTON, OHIO—The Ft. Wayne, Dayton & Cincinnati Traction Company has obtained the right of way for 400 miles of its proposed road without a single condemnation suit. The third-rail system will be used.

INDIANAPOLIS, IND.—It is said that the Wabash Railroad Company will build a line connecting Wheeling and Lake Erie with the Wabash, the new line to extend from Zanesville, Ohio, to Parkersburg, W. Va.

CLYDE, N. Y.—The engineers of the Syracuse & Rochester Electric Railway Company are looking over grounds to locate the power-house for their line. This power-house with its machinery and car shops will cost about $6,000.

LEXINGTON, KY.—The Blue Grass Consolidated Traction Company has been granted a franchise calling for an electric line from the Fayette County line to Nicholasville and one from Nicholasville to the Kentucky River toward Lancaster.

PITTSBURGH, PA.—At a recent stockholders' meeting of the Meyersdale & Salisbury Street Railway Company, the capital was raised from $36,000 to $250,000 and arrangements made to carry out the project of building a line between Meyersdale and Salisbury.

DUNKIRK, N. Y.—Mr. Arthur C. Wade, of Jamestown, president of the Lake Shore Traction Company, has asked for a franchise to construct a street railroad between Westfield and Silver Creek. No opposition is anticipated, but the matter will be deferred for a brief period.

UTICA, N. Y.—Electrical substations for the Utica & Mohawk Valley Railway are being constructed for the purpose of handling the current generated at Trenton Falls, and which is supplied to the railway by a special transmission line. These substations are being built of steel and brick, and it is said that they will cost about $6,000 each exclusive of equipment.

## ELECTRIC LIGHTING

ST. JOSEPH, MO.—St. Joseph now has an all-night lighting system throughout the business portion of the city.

GREENVILLE, ILL.—E. G. Brackman, of St. Louis, has sold the Greenville electric light plant to a syndicate of Greenville business men for $25,000.

OSHKOSH, WIS.—Contracts to the amount of $49,000 have been let and work has been begun on the plant of the Ohio Electric Light and Power Company.

HOPKINSVILLE, KY.—A modern and complete equipment has been installed by the Hopkinsville Gas and Lighting Company. This includes engine and dynamo.

BIRMINGHAM, TENN.—The Birmingham Railway, Light and Power Company is making improvements to the extent of $1,000,000 in and around Birmingham.

DOYLESTOWN, PA.—The Doylestown Electric Company has awarded the contract for the addition to its power-house to William L. Hager, a local bidder. There were several estimates.

CHATTANOOGA, TENN.—The Bristol Gas and Electric Company's plant and the Bristol Belt Line Railway Company have passed into control of a new company under one management.

LEXINGTON, KY.—At a meeting of the stockholders of the Blue Grass Consolidated Rapid Transit Company, held recently, a board of trustees was elected and the issue of $7,000,000 worth of bonds authorized.

PEORIA, ILL.—The village trustees have awarded to the Peoria Gas and Electric Company a five-year contract for lighting the streets of the village and have granted a thirty-year franchise for furnishing lights to the residents.

MEDIA, PA.—The Media borough council has turned on the current at the new municipal light plant almost a week before contract time. An injunction asked for by the Media Electric Company to prevent the light from burning was refused by Judge Johnson.

YORK, PA.—The Merchants' Electric Light and Power Company has begun to furnish power for commercial purposes. The plant of this company, which has been under construction for a considerable portion of time, is modern in every way as regards its equipment.

DALLAS, TEX.—Granville P. Meade, of Fort Worth, Tex., has been appointed by the Federal Court receiver of the Standard Light and Power Company, of Dallas, upon application of the General Electric Company, of New York. The amount involved exceeds $50,000.

SCRANTON, PA.—The Lackawanna Valley Electric Light and Power Company has secured a big contract from the Delaware & Hudson Company. The contract calls for the lighting of all the shops in this city of that company. The electric light employés will soon start at the work of wiring.

## ELECTRICAL SECURITIES

Speculation has been rather dull, and the week in the market has presented few important features. The general tone has been one of heaviness and unsettlement, and while prices moved with some irregularity, the general trend was downward, the closing quotations showing a majority of slight declines.

A good bank statement, showing a gain in the surplus reserves of $6,270,000, failed to effect a stimulus, a rumor from the West to the effect that the Coal Miners' Association would make demands and uneasiness over the outcome of the Northern Securities merger having a depressing effect.

ELECTRICAL SECURITIES FOR THE WEEK ENDING JANUARY 25.

| *New York:* | Closing. |
|---|---|
| Brooklyn R. T. | 66 |
| Con. Gas | 217 |
| Gen. Elec | 280 |
| Man. El | 135 |
| Met. St. Ry | 169⅝ |
| Kings Co. Elec | 187 |
| N. Y. & N. J. Tel. Co | 169 |
| Telep., Tel. & Cbl. Co | 5 |

Metropolitan rose about eight points upon a rumor that it was to be united in a combination with the Consolidated Gas, but weakened toward the close of the week. The report that Brooklyn Rapid Transit may be the successful bidder for the construction and operation of the Brooklyn extension of the underground rapid transit railroad receives little credence in outside quarters.

| *Boston:* | Closing. |
|---|---|
| Am. Telep. & Tel | 158½ |
| Edison Elec | 260 |
| Erie Tel. Trust Receipts | 21 |
| New Eng. Tel | 145 |
| Mass. Elec. pf | 92½ |
| Westing. Mfg. pf | 90 |

The American Telephone and Telegraph Company announces that it has acquired full control of the Erie telephone interests. Application for a temporary injunction to stop the transfer was denied in Equity Session of the Superior Court at Boston.

| *Philadelphia:* | Closing. |
|---|---|
| Elec. Co. of America | 5¾ |
| Philadelphia Elec | 3¼ |
| Union Traction | 35¼ |
| United G. I. Co | 116½ |
| Elec. Stor. Bat. c | 62 |
| Elec. Stor. Bat. pf | 65 |

All the Philadelphia banks and trust companies have lowered rates from 5 to 4½ per cent, making the second reduction in the week. It is stated that notes of the Metropolitan Traction Company aggregating $100,000 were discounted in this city on Friday.

| *Chicago:* | Closing. |
|---|---|
| Central Union Tel | 40 |
| Chicago Edison Light | 163 |
| Chicago Telep | 185 |
| Metropolitan El. pf | 90½ |
| National Carbon | 20 |
| National Carbon pf | 83½ |
| Union Traction | 11½ |
| Union Traction pf | 47½ |

## TELEPHONE AND TELEGRAPH

NEW HAVEN, CT.—The farmers of the western part of Orange have established a cooperative telephone system.

JOHNSTOWN, PA.—The Bedford County Telephone Company is building a line from Bedford to Ashcom Station.

LYONS, N. Y.—The American Telephone and Telegraph Company is building a line between this village and Phelps.

PERTH AMBOY, N. J.—The American Telephone Company has completed its canvass and will soon install an exchange.

NEW DECATUR, TENN.—A telephone war is being waged here, with possible result of a new company from Chicago locating.

SCOTTSBORO, ALA.—The independent telephone line under construction from Point Rock to Stevenson will soon be completed.

TAMPA, FLA.—The Peninsula Telephone Company is working a large force of men laying conduits through the business section of the city.

MONTCLAIR, N. J.—The Montclair-Bloomfield Telephone Company's central office was destroyed by fire early on the morning of January 26.

SENECA FALLS, N. Y.—The Home Telephone Company is having some difficulty, owing to the opposition of residents, in placing its telephone poles.

NEW HAVEN, CT.—The Southern New England Telephone Company put in 3,613 new instruments during the past year. More extensions are contemplated.

CHEYENNE, WYO.—The Powder River Telephone Company has completed its line from Buffalo to Kaycee, opening up communication for half a dozen small settlements.

CHARLESTON, TENN.—Work on the telephone exchange has begun, and a force is engaged in putting up poles and wire. The central office will be in the Knox Building.

LOUISVILLE, KY.—The long-distance telephone lines which are being built to connect the Fayette company with the Louisville exchange, will be finished within a month or six weeks.

PHILADELPHIA, PA.—The Keystone Telephone Company, the rival of tne Bell interests in this city, has begun sending messages over its new lines. The work not yet finished will be rapidly pushed to completion.

PORTVILLE, N. Y.—The Interocean Independent Telephone Company, which is building a line, has reached Portville. The line will soon be completed to Olean, where it will connect with the Union Telephone Company's lines.

PITTSBURGH, PA.—An increase of $2,500,000 in the capital stock of the Central District and Printing Telegraph Company is to be voted upon by the stockholders at the annual meeting of the company February, 13. This will, if passed upon favorably, make the capital of the corporation an even $10,000,000. The company is planning extensive new operations.

## NEW INCORPORATIONS

CINCINNATI, OHIO—Union Light and Heat Company. $35,000.

CLARK COUNTY, KY.—Winchester Railway, Light and Ice Company. $100,000.

SEA CLIFF, L. I.—The Nassau County Railroad Company. $25,000. To operate a trolley railroad. The directors are nearly all Brooklyn men.

WYANET, ILL.—Wyanet Electric Light Company. $12,000. To operate an electric light, heat and power plant. Incorporators: Constant Brown, Jr., P. Jones and Ellsworth White.

PLAINVIEW, MINN.—The Greenwood Telepnone Company. $25,000. To build independent lines of telephones connecting Plainview, Weaver, Theilman, Kegan and Beaver. Incorporators: Andrew French, F. D. Washburn and others.

TRENTON, N. J.—United States Light and Heating Company. $3,000,000. To furnish electricity, light and heat, especially for railways and railway cars. Incorporators: Mr. W. B. Irwin, Mr. Wallace Young and Mr. John J. Gilbert, all of Jersey City.

WHITE PLAINS, N. Y.—The Hudson Valley Light and Power Company. $25,000. To furnish electric lights for the villages of Ossining, North Tarrytown, Newcastle, Greenburg, North Castle, Mount Pleasant and other villages and towns in Westchester County.

COLUMBIA, S. C.—Renault Insulator and Electrical Construction Company. $25,000. Incorporators: Edward Renault, of Waldo, Fla.; Charles Warren Davis, John O. Wicker and George Nees, of Augusta. To manufacture electrical insulators from porcelain, mica, clay, etc., and mine, wash and crush various kinds of clay.

AMHERST, MASS.—Hampshire Street Railway Company. $100,000. One thousand shares at $100 each. To build a railway from the Amherst boundary line between Belchertown and Granby to a point near and connecting with the tracks of the Holyoke Street Railway Company, its terminus. Directors: W. D. Cowls, John C. Robinson, Charles C. Bardwell and others.

MONTREAL, CANADA—Messrs. Charles Henry, Albert and John Garth and J. G. Smith, of Montreal, at the coming sessions of the Legislative Assembly, will apply for permission to establish a new company under the name of the Garth Company. The company will manufacture all kinds of electric, gas and steam apparatus. The capital will be $175,000,000, divided into 1,750 shares of $100 each.

ATLANTA, GA.—An application for a charter has been filed in the office of the Secretary of State, asking for the incorporation of a company to be known as the Georgia Railway and Electric Company. The capital stock is to be $3,000,000. The application is for 101 years, and includes a right of franchise in all the streets and roads in Fulton County and De Kalb County. The charter, if granted, would also give the company the right to own and operate electric plants, furnish electric power and steam heat. The applicants for the charter are all residents of Atlanta.

## INDUSTRIAL ITEMS

THE KNAPP ELECTRIC AND NOVELTY COMPANY, New York city, finding it necessary to enlarge its plant, has moved and is now located at 511 and 513 West Fifty-first street.

THE VALENTINE-CLARK COMPANY, Chicago, Ill., make a specialty of cedar poles. A booklet descriptive of their various pole-yards and treating on cedar poles in general will be sent on request.

D. L. BATES & BROTHER, Dayton, Ohio, manufacturers of desk and bracket fans for direct and alternating current and ceiling fans for direct current only, will send their "little book about fans" to those interested.

JAMES CLARK, JR., & COMPANY, Louisville, Ky., manufacturers of the "Willey" electrically driven tools, will send to enquirers a handsome catalogue illustrative of an interesting line of electrically driven tools and small motors for individual driving.

THE CHASE-SHAWMUT COMPANY, Boston, Mass., manufacturer of fuse wire, fuse links, switches, switchboards, electrical stage lighting apparatus, etc., is sending out a unique and interesting booklet of instructive "Electrical Data." Copies on request.

THE ACME PATTERN MANUFACTURING COMPANY, Milwaukee, Wis., announces that it has increased its capacity for turning out patterns, and is making a specialty of the electrical business. The company makes wood and metal patterns and models of all description, especially for electrical apparatus.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., is advertising a new addition to the family of Adams-Bagnall arc lights. It is a series alternating in both shunt and differential types. The shunt type is the one used with the so-called regulator system, and the differential is for use with "tub" or transformer system.

THE BUCKEYE BOILER SKIMMER COMPANY, Cleveland, Ohio, is sending forth a neat booklet illustrating and describing the method of cleaning steam boilers with the Buckeye automatic boiler cleaner. This apparatus is designed to rid a boiler of scale and sediment, and to maintain a constant relation with the boiler water irrespective of depth.

THE AMERICAN ELECTRIC FUSE COMPANY, New York, Chicago and Atlanta, large manufacturer of telephone protective apparatus, is sending on request a unique little reminder called its "Baby Book." Pictures of forty babies share attention with the description of the company's apparatus, making an interesting and handsome booklet.

THE CENTRAL ELECTRIC COMPANY, of Chicago, will be pleased to quote upon application on I. X. L. slow burning, weather-proof wire, office annunciator, magnet, and galvanized telephone wire. The company will also gladly furnish prices on Okonite insulated wires and cables for aerial, submarine, and for general use where an insulated wire is required.

THE WESTERN ELECTRIC COMPANY, Chicago, Philadelphia, St. Louis and New York, has published a handsome catalogue containing some 1,100 pages and 3,000 illustrations. This book appears to list everything which could possibly be wanted in any line of electrical industry. The catalogue will be sent to any address, charges paid, upon receipt of $1.

THE AULTMAN COMPANY, Canton, Ohio, invites large and small users of coal to send specifications and rough sketches of the available space and the kind and quality of material handled, and it will prepare a design and estimate as to the adaptability of the Aultman system for coal and ash-handling equipment. It also offers to send its catalogue of this apparatus upon enquiry.

THE STERLING ELECTRICAL MANUFACTURING COMPANY, Warren, Ohio, is a company organized during the year just closed for the manufacture of incandescent lamps. The company erected a new factory convenient to shipping facilities, and its management is composed of men practical in the manufacture of incandescent lamps. It reports that its success has been quite pronounced and it has already outgrown its facilities.

THE D. M. STEWARD MANUFACTURING COMPANY, Chattanooga, Tenn., manufacturer of the Lava insulators, is putting an absolutely new product on the market in the form of "Stainoff." This article, the company claims, is an exceptionally good eradicator of stains of any nature from the fingers and hands, and is used in the same manner as ordinary soap. It is neatly packed in leather-bound brass cartons, in the popular round stick shape.

THE HAINES & NOYES COMPANY, Chicago, Ill., makes a specialty of apparatus for private telephone plant use. Constant growth has made increased capital and space necessary, and the company now announces that it is able to turn out a fine line of apparatus at low figures, for every possible use. The company also manufactures special waterproof and damp-proof instruments for mines, and a special line for electric and steam railways, hotels and office buildings.

THE PACIFIC ELECTRICAL WORKS, San Francisco, Cal., has recently opened its new insulating works at Los Angeles, and has installed a complete equipment of modern machinery for the manufacture of water-proof, annunciator and magnet wire and cables, and announces that it is now ready to make prompt shipments. The company has in its manufacturing department practical men, and guarantees every pound of its output. This plant, it is believed, is the only one of its kind in the far West.

P. & F. CORBIN, New Britain, Ct., large manufacturers of hardware, furnished all the hardware required for equipping the magnificent new Frick office building at Pittsburgh, which is said to be the finest structure of the kind in the world. The hardware was of a special design made from the architect's drawings, and the locks used were the new unit system of locks which is now being used on the modern buildings in the principal cities. The Corbin door check was used throughout the building.

THE UNITED STATES ELECTRIC MANUFACTURING COMPANY, Butler, Pa., is now offering the selective lock-out party-line telephone system as being thoroughly commercialized. This system was recently illustrated and described in this journal. It is designed for use on isolated lines and exchange service, as it may be applied to any exchange board. Thirty-five telephones may be operated on one line, and calling all subscribers when only one is wanted is done away with. This company has recently purchased the patents of the Drake Telephone Company, covering the Drake selector and battery cutout.

THE S. H. COUCH COMPANY, 200 Summer street, Boston, Mass., is the name of a new telephone manufacturing company just organized by Samuel H. Couch, formerly with the Couch & Seeley Company. Mr. Couch announces that he has disposed of his entire stock and interest in the Couch & Seeley Company, and that the new company is prepared to furnish all types of telephone instruments and switchboards, either magneto calls or central energy systems; also interior systems, terminal heads, distributing boards, protective devices, magneto bells and other telephone accessories.

BAKER & COMPANY, gold, silver and platinum refiners, of Newark, N. J., and New York, have issued the following under date of January 25, 1902: "As a number of rumors have reached us that we have sold all or a portion of our business and that we have joined forces with other platinum interests, we take this means of advising our customers, friends and the trade in general that no change of any description has taken place in our concern, nor are we in any combination whatever, and that we continue to give all that favor us with their patronage our very best effort in filling all orders entrusted to us, with extreme care and accuracy, supplying the best quality at the lowest possible price."

WESTINGHOUSE, CHURCH, KERR & COMPANY —In the list of sales by Westinghouse, Church, Kerr & Company during the last month there are included several interesting stoker, mechanical draft and economizer equipments. The New York office reports an order for two 100-inch 24-grate stokers to Obermeyer & Liebman, of Brooklyn; a complete stoker and economizer plant, with stack and mechanical draft, to the Union Bag and Paper Company, of Sandy Hill, N. Y.; two 138-inch 24-grate, and four 132-inch 22-grate stokers to the British Westinghouse Electric and Manufacturing Company at Manchester, England. The Boston office reported the sale of an equipment of dampers and actuating mechanism for economizers to Sanderson & Porter for the Rockingham County Light and Power Company at Portsmouth, N. H., and the Detroit office three 54-inch 20-grate stokers to Colonel Frank J. Hecker for the Washington Arcade Building plant in Detroit. The Chicago office added a list of four plants, comprising 12 stokers, and including a 48-inch 20-grate stoker to Sligar & Holloway, Indianapolis; one 84-inch 22-grate stoker to the United States Board and Paper Company, of Carthage, Ind.; eight 54-inch 22-grate stokers to the United States Mining Company at Salt Lake City, Utah, and two 93-inch 22-grate stokers to Deere & Company, of Moline, Ill.